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ABSTRACT

GRADES OR AGES: Grades 9-12. SUBJECT MATTER: Technical subjects and special mathematics and science courses for technical students. Technical subjects include air conditioning, auto mechanics, carpentry, drafting, applied electronics, masonry, painting, plumbing, service station operation, welding, and woodworking. ORGANIZATION AND PHYSICAL APPEARANCE: The guide is divided into three main sections, one each for a 5-year program, a 4-year program, and a 2-year program. Each section contains course outlines for from 8 to 22 courses. The guide is xeroxed and perfect bound with a paper cover. OBJECTIVES AND ACTIVITIES: No specific objectives or activities are mentioned. Most units simply list in detail topics to be covered with suggestions for timing. INSTRUCTIONAL MATERIALS: No mention. STUDENT ASSESSMENT: No mention. (RT)

Curriculum RP-27

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ONTARIO
DEPARTMENT OF EDUCATION

THE SCIENCE, TECHNOLOGY, AND TRADES BRANCH

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TECHNICAL SUBJECTS

Courses of Study for
The Five-Year Programme Grades 11 and 12
The Four-Year Programme Grades 9, 10, 11 and 12
The Two-Year Programme Grades 9 and 10

Replacing Curriculum I and S-27, The Technical Course

MATHEMATICS

Courses of Study for
The Four-Year Programme Grades 10, 11 and 12

Reprinted from Curriculum I and S-27, The Technical Course

SCIENCE

Courses of Study for
The Four-Year Programme Grades 10, 11 and 12

Reprinted from Curriculum I and S-27, The Technical Course

**These courses are experimental in that they will be subject to review.
Suggestions for their improvement will be welcomed.**

SP007130

TABLE OF CONTENTS

Four-Year Programme Page

Introduction 3
Aircraft, Grades 10 to 12 7
Air Conditioning and Refrigeration, Grades 9 to 12 23
Applied Electricity, Grades 9 to 12 33
Applied Electronics, Grades 11 and 12 44
Auto Body Repair, Grades 9 to 12 52
Auto Mechanics, Grades 9 to 12 61
Drafting, Grades 9 and 10 68
Drafting - Architectural, Grades 11 and 12 71
Drafting - Electrical, Grades 11 and 12 77
Drafting - Mechanical, Grades 11 and 12 79
Graphic Arts, Grades 9 to 12 83
Industrial Chemistry, Grades 11 and 12 94
Industrial Physics, Grades 11 and 12 98
Machine Shop Practice, Grades 9 to 12 103
Plumbing, Grades 9 to 12 109
Sheet Metal Practice, Grades 9 to 12 113
Welding, Grades 9 to 12 121
Woodworking, Grades 9 and 10 138
Woodworking - Building Construction, Grades 10 to 12 141
Woodworking - Cabinetmaking and Millwork, Grades 10 to 12 146
Woodworking - Pattern and Casting Processes, Grades 10 to 12 151
Related Technical Courses, Grades 11 and 12 157
    Introduction 157
    Art 157
    Drafting 158
    Electricity 163
    Machine Shop Practice 164
    Pattern and Casting Processes 168

Sheet Metal 169

Small Engines 171

Welding 173

Five-Year Programme

Comment on the Courses for Grades 9 and 10 177

Drafting - Architectural, Grades 11 and 12 178

Drafting - Mechanical, Grades 11 and 12 182

Electricity, Grades 11 and 12 184

Electronics, Grades 11 and 12 188

Industrial Chemistry, Grades 11 and 12 192

Industrial Physics, Grades 11 and 12 195

Machine Shop Practice, Grades 11 and 12 198

Two-Year Programme

Introduction 201

Carpentry 202

Drafting 205

Dry Cleaning 208

Electrical Construction 212

Graphic Arts 217

Machine Shop Practice 223

Masonry 226

Painting and Decorating 229

Service Station Operation 232

Sheet Metal 234

Small Engines 238

Welding 242

Mathematics, Grades 10, 11 and 12, Four-Year Programme 250

Science, Grades 10, 11 and 12, Four-Year Programme 259

SCIENCE, TECHNOLOGY AND TRADES BRANCH

Four-Year Programme

The Science, Technology and Trades Branch offers a number of day courses covering a Four-Year Programme of education leading to a Secondary School Graduation Diploma.

In addition to the study of basic academic subjects, the Four-Year Programme in this Branch offers specialized instruction in Technical Subjects. These courses are designed for pupils who have special interests and aptitudes in the technical or practical fields of business and industry and who expect on graduation to enter employment in the type of work for which these studies have direct practical value.

During the first two years instruction in Technical Subjects is exploratory in nature and the pupils spend some time studying all or most of the Technical Subjects available in a particular school. This provides an opportunity to ascertain the special aptitudes, capacities and interests of the pupil.

Unless provided for under the Guidance Programme of the school, definite information with respect to the opportunities and requirements of the various occupations should be made available to the pupils by the teachers of Technical Subjects. The pupil is thus assisted in making an intelligent selection of a Technical Subject in which to major or specialize in Grades 11 and 12 preparatory to admission to a trade or industry.

The courses in Technical Subjects are designed to encourage logical thinking, to develop an appreciation of good design and the principles involved, to instill good work habits and to give training in the basic skills and technology associated with the type of work the pupil expects to enter upon graduation from a secondary school.

RELATED SUBJECTS

Pupils enrolled in Grade 11 are required to elect a major Technical Subject in which to specialize. In Grades 11 and 12 pupils spend the major portion of the time allocated to Technical Subjects (See H.S. 1.) studying a major Technical Subject and the remainder on one or more related Technical Subjects. The functions of the related courses are to supplement the instruction in the major subject, and show the interrelationship of the different trades.

One or more related Technical Subjects may be selected for Grade 11 and continued through Grade 12 or another subject or group of subjects selected for Grade 12. The related courses studied will depend on the major courses offered, the varying demands of industry and the capacity of the school organization to meet the needs of individual pupils.

Details of the courses in related subjects are set out on pages 157 to 176. The major and typical related Technical Subjects should be chosen from this list.

Major Technical Subjects	Typical Related Technical Subjects
Aircraft Mechanics	Drafting, Machine Shop, Electricity, Welding
Air Conditioning and Refrigeration	Drafting, Sheet Metal, Electricity
Applied Electricity	Drafting, Electronics, Machine Shop, Carpentry
Applied Electronics	Drafting, Electricity, Machine Shop
Auto Body Repair	Welding, Auto Mechanics, Machine Shop
Auto Mechanics	Electricity, Commercial Work, Machine Shop, Welding, Small Engines, Auto Body Repair
Drafting, Architectural	Building Construction, Sheet Metal, Plumbing
Drafting, Electrical	Electricity, Electronics
Drafting, Mechanical	Machine Shop, Pattern Making, Welding Electricity
Foundry Practice	Pattern Making, Machine Shop, Drafting
Graphic Arts	Commercial Art, Photography, Drafting
Industrial Chemistry	Drafting, Electricity
Industrial Physics	Air Conditioning and Refrigeration Drafting, Electronics, Machine Shop
Machine Shop Practice	Drafting, Welding, Pattern Making, Auto Mechanics, Electricity
Power Plant Operating	Drafting, Auto Mechanics, Electricity, Diesel Mechanics
Plumbing	Building Construction, Welding, Sheet Metal, Drafting
Sheet Metal Practice	Drafting, Welding, Machine Shop, Plumbing, Air Conditioning and Refrigeration
Welding	Drafting, Machine Shop, Electricity
Woodworking-Building Construction	Architectural Drafting, Sheet Metal, Electricity
Woodworking-Cabinetmaking and Millwork	Drafting, Sheet Metal, Electricity
Woodworking-Pattern and Casting Processes	Drafting, Machine Shop

Pupils in Grades 11 and 12 may elect a business option in lieu of a related Technical Subject. The usual arrangement is: Grade 11, Typewriting; Grade 12, Record Keeping and Bookkeeping (See RP-31).

Those who obtain a Diploma in the Technical Course may enter a special one-year course in Technical Subjects, Business, Commercial Subjects, Home Economics or Vocational Art.

SPECIAL TECHNICAL COURSE

A special one-year Technical Course may be set up subject to the approval of the Minister. (See H.S.1.)

MAJOR TECHNICAL SUBJECTS

Suggestions Regarding Technical Courses

The division of time between academic and technical subjects is set out in Circular H.S.1. The courses in the Technical Subjects contained herein are quite extensive and it may be necessary to modify the courses to suit the time available.

The course outlines for the Technical Subjects in vocational schools as provided herein are not necessarily arranged in order of presentation. In schools where it may be desirable to teach courses other than those outlined such courses of study should be submitted for the approval of the Minister before they are adopted. In organizing time-tables, the semester plan or the rotary plan is suggested in order to reduce the number of subjects carried concurrently by pupils.

The project is the usual basis for the presentation of technical instruction. Projects to cover the topics of the course should be selected with a view to the interests and abilities of the pupils and should offer sufficient variety. Pupils should be encouraged to choose from several suitable projects or to make modifications to the class project. The well-directed use by the pupils of carefully planned shop libraries, illustrative materials, trade magazines and other instructional aids will promote the close co-ordination of intelligent study with the development of recognized standards of performance in trade operations.

In planning and presenting instruction, teachers should take into account previous training and experience which pupils have had, whether in school or elsewhere.

From these courses the teacher should make a detailed organization of the work for each class. Wherever possible problems should be introduced which require numerical calculations. Frequent and systematic appraisal of the pupil's work should be made, giving credit for achievement in practical work, tests and examinations, home-work, assignments, note-book records and, if desired, general adaptability to the instruction.

Pupils majoring in a Technical Subject must take related Technical Subjects. To conserve shop time for technical work the science, mathematics and drafting related to the various Technical Subjects should be taken in the respective departments.

REPORT WRITING

Writing reports should be part of the work in Technical Subjects. Reports should be written on all experimental work and be well prepared with the ideas clearly expressed.

In the years of Grades 11 and 12 students in the Technical Course should refer to technical articles in trade journals and other publications and write a report on a suitable topic. This gives the pupil practice in clarity of expression, training in the analysis of information and experience in the use of reference materials.

PLANT TOURS

Students should be made familiar with new processes and new techniques, therefore, well-arranged plant tours are effective in an educational programme. Plant visits should be for a specific purpose, timed suitably for the work in progress at school and not for a general overall look. Before going on a plant tour the pupils should be briefed on its purpose and phase of the work to be studied. An assignment following the plant tours checks the learning that took place, gives the pupils practice in describing a technical process or operation and trains them in careful observation.

SAFETY

Dangerous conditions affecting the health and safety of pupils must be avoided. Exhaust gases from running engines and fumes from spray guns and heat-treating processes must be effectively discharged. All machines must be properly guarded; safety instruction should be given in every shop where hazards exist and a first-aid cabinet must be readily accessible. A clean and well-appointed shop, with equipment maintained in first-class operating condition is an important factor in the prevention of accidents.

AIRCRAFT

Four-Year Programme Grades 10, 11 and 12

Grade 10

Airframes

Parts and Materials

Names, function, materials used, and location of the main parts of fuselage, wing and tail assemblies; construction, function and operation of main control surfaces; lights, their location and use.

General

Discussion of various types of aircraft such as airplanes, helicopters, autogiros, Vertical Take-off and Landing Aircraft (V.T.O.L.'s) and Short Take-off and Landing Aircraft (S.T.O.L.'s), classification of airplanes by wing shapes and location; demonstration of airfoils to show lift; airport characteristics and procedures

AIRCRAFT

Grade 10

Aero Engines

This study is confined to four-cylinder opposed type engines.

Safety

Shop organization and safe practices

Parts

Investigation to obtain knowledge of the location, function and materials used in the following: overhead valve mechanisms, pistons, piston rings, connecting rods, crankshaft, bearings, cylinder and cylinder head assemblies

Fuel System

Carburetion: purpose and function of a simple carburetor; tracing a fuel system including tank, pump, filter, shut-off valve, selector valve and carburetor

Lubrication System

Tracing the lubrication system of a four-cylinder opposed type engine, operation of the gear type oil pump and oil filters

Cooling System

Operation of an air cooling system, the use of fins, baffles and cowlings

General

The operation of two-and four-stroke cycle internal combustion engines and an introduction to the operation of gas-turbine engines; classification of internal combustion engines; identification and use of tools, threads and fastenings; removal and replacement of cylinder and piston assemblies, piston rings, valves and studs; hand valve re-conditioning, valve clearance adjustment, locking fastenings, cutting gaskets. Starting and running adjustments on several small engines and a six-cylinder automotive engine, safety precautions

AIRCRAFT

Grade 11

Airframes

Safety

Safe practices in the following: the handling of propellers; slinging, hoisting and jacking aircraft. The use of eye shields, goggles, and fire extinguishers

Parts and Materials

A detailed study of the construction features and the materials used in: wings, wing spars, wing ribs, wheels, wheel bearings, cables, turnbuckles, clevis pins, bolts and other fastenings. A.N. Number system

A brief survey of aircraft woods, plywood, glues, wood protectives; airplane dope and its function, specifications of fabrics, fabric stitching, fabric surface tape and reinforcing tape, types of seams, use of grommets and zippers, classification of metals and heat treatment

Operations

Locking of airframe parts, wrapping splices, tieing rope knots, removing and assembling wheel units, tube repair, covering a small frame with fabric, applying dope with a brush, rubbing down the doped surface to finish. Tuck splicing, mechanical swaging, use of cable clamps, rope splicing; assembling and alignment of wheel, float, and ski undercarriages; flying control inspection and adjustment, preparation of a structure for fabric covering, repair of fabric, shock cord whipping, metal protection, dismantling and assembling a complete tail unit, checking tail-plane rigging. Aircraft shop routines and organization

General

A study of the stresses to which aircraft parts are subjected; ultimate tensile strength, ductility and other metallurgical terms; fire prevention and ventilation; operation of a dope-room; use of thinners, and rejuvenators; bonding

AIRCRAFT

Grade 11

Aero Engines

A radial engine of medium horsepower is required for instruction.

Safety

Safety precautions should be stressed

Parts

A detailed study of: crankshafts, connecting rods, pistons, piston rings, valves, valve operating mechanisms, cylinders, cylinder heads and crankcases

Fuel System

Detailed inspection of gravity and pressure fuel system, fuel line identification. Construction and use of: fuel tanks (rigid and rubber), filter units, selector and shut-off valves, gauges, primers and fuel pumps.

Lubrication System

A detailed study of the radial engine dry sump lubrication system. Construction and operation of: oil pumps, oil coolers, filters, pressure and temperature valves and oil tanks; dismantling for inspection; procedure and purpose of oil changing

Cooling System

Liquid cooling Construction and operation of: radiators, themostats, pumps and cooling jackets. Use of anti-freeze; application and installation of hose and hose clamps

Air cooling Detailed study of: fins, baffles, ducts, cowlings, cowl vents and airflow

Gas Turbine Engines

Theory of jet propulsion, basic operation of centrifugal and axial flow jets, classification of gas turbine, jet and rocket engines

General

Decarbonizing and cleaning: cylinder heads, pistons, valves and valve guides. Detailed study of: fastenings, bolts, nuts, cap screws, studs and set screws; the removal of broken studs; the use of step studs and helicoil threads; parts inspection, measuring cylinders for out-of-round and taper, checking piston pins and piston rings for wear, commercial methods of crack detection ("magnaflux" and "zyglo"), heat treatment and forming metal; practice in the use of reamers, hones, taps and dies; scratch removal and the treatment of scores, machine valve re-conditioning, fitting piston rings; engine firing orders, power impulses, valve lead, lag and overlap, valve timing diagram, camlift and dwell; valve timing on the engine; types and use of fire extinguishers; starting and running a four cylinder aircraft engine, safe operating practices

AIRCRAFT

Grade 11

Electricity

Simple explanation of electrons, protons and structure of atoms; experimental study of circuits, conductors, resistors and insulators; meaning of voltage, current and resistance; Ohm's law; use of voltmeter and ammeter; magnetism; magnetic field about a current carrying conductor and helix; electromagnetism

Battery Ignition Systems

Construction and function of: breaker points, condensers, H.T. coils and distributors; installation and adjustment of breaker points; ignition timing, trouble shooting the system

Spark Plugs

Types, construction, servicing, removal and installation

Storage Batteries

Construction, operation, testing, charging, installing and handling

AIRCRAFT

Grade 11

Aircraft Theory

General

A study of aircraft terminology: types of aircraft, parts, general and flying terms

Experiments

To show the following: the function of flying controls, pressure change in a venturi tube and about a wing shape, variation of lift with angle of attack and velocity of airflow, change of drag with angle of attack and velocity of airflow, movement of centre of pressure, effect of flaps and slots on lift and stalling characteristics of a wing, comparing the drag of various shaped objects and observing the airflow about them

Problems

Solving simple navigation problems involving air speed, ground speed, wind, variation and deviation; wing loading, power loading and aspect ratio

Air Regulations

Scope of the Aeronautics Act, rules for air traffic, aircraft markings and lights, breach of air regulations; aircraft, engine, and propeller log books, personnel

Engineering Handbook of the Department of Transport

A selection of items covered to familiarize students with the scope of this manual and a discussion of the origin of and need for several of the directives

General

A detailed study of the following: stability; lateral, longitudinal and directional stability; balancing controls by horn, inset hinge and balance tab method; Frise and differential ailerons, adjustable stabilizers, trim tabs

AIRCRAFT

Grade 11

Instruments

A detailed study of the construction, operation and use to the pilot of each of the following instruments: air speed, vertical speed, altimeter, compass, directional gyro, artificial horizon, turn and bank, manifold pressure, Bourdon tube types, centrifugal and electrical tachometers, and fuel gauges

Testing of the above using dead weight testers and test bench; instrument panel servicing; deviation, variation and swinging a compass

AIRCRAFT

Grade 11

Sheet Metal

Metals used in aircraft and their location in aircraft structures. A detailed study of aluminum and its alloys; the care and handling of aluminum sheet stock; identification and marking of steel and aluminum alloys; the use and care of templates; head markings and colour code for rivet identification; storage, handling and heat treatment of rivets; specialized rivets and their use. Buffing wheels, compounds, abrasives; burnishing and surface preparation; methods used in metal finishing

Operations

Laying out from blueprints and working from templates; cutting and drilling flat stock and the use of metal holders. Operation and care of: pneumatic drills, rivet hammers, rivet squeezers and cherry rivet guns. Using bending blocks, bumping forms, dies and sand bags. Counter-sinking, dimpling, stretching and shrinking metal using hand tools. Identifying and removing defective rivets

AIRCRAFT

Grade 12

Airframes

Safety

Safety precautions should be stressed

Parts and Materials

A detailed study of the construction of landing gears, fuselages, propellers, propeller governors and constant speed control units

Overhaul and Testing

A study of and practical work on the overhaul and testing of the following hydraulic units: flap and undercarriage actuators, relief and selector valves, hand pumps, engine-driven pumps, oleo legs, accumulators, pressure-control valves, master brake cylinders, wheel cylinders, constant speed propeller controls, controllable pitch propellers, hydraulic brake units, and multi-disc brake assemblies

Servicing and Adjusting

A study of and practical work on the servicing and adjusting of the following: hydraulic and mechanical brakes, retractable undercarriages, controllable pitch propellers, propeller control units, trimming tabs, balance tabs and flaps. An airplane to rigging position for checking fuselage alignment, tail-plane alignment, dihedral and angle of incidence of the wings. Inspection after a hard landing

General

The use and maintenance of paint spraying equipment, principles of hydraulics, airplane slinging, dismantling and assembling wings, repairing steel tubing, protection of metals, fabrication of hydraulic tubing. The selection and application of tube fittings; weight and balance; flying faults and their correction; ground handling of aircraft on wheels, floats and skis; types and servicing of de-icing equipment

AIRCRAFT

Grade 12

Aero Engines

Instruction to be given on: (a) Radial and opposed reciprocating engines, (b) Centrifugal and axial flow turbine engines

Parts

Investigation to obtain knowledge of the location, function and materials used in the following: supercharger drive assemblies, impellers and diffusers, reduction gear units, carburetors (standard and injection), induction and exhaust components. Turbo-jet engine: compressors, diffusers, combustion chambers, turbine units, burners, fuel pumps and fuel control units

Fuel System and Carburetion

A detailed study of fuel requirements throughout the speed and power range of the engine. A comprehensive study of the carburetor including construction and operation of: float mechanisms; fuel discharge, line and idling jets; accelerating, economizer, altitude and idle cut off systems; ice formation, heat application, detonation and water injection. A study of fuel injection and fuel injection carburetors. Supercharging: investigation and study of single and two-stage superchargers, induction air cooling and turbo superchargers. Procuring, refining and testing gasoline; aero engine fuel requirements

Lubrication

Refining and manufacture of lubricants, review of types of oils and greases, engine requirements, the preparation of the lubrication system for cold weather operation; oil dilution - purpose and procedure

General

Piston engine power ratings, indicated and brake horsepower, calculating engine power, use of indicator diagram; slinging, handling, storing and installing engines and the safety measures to employ; daily and periodic engine inspection; trouble shooting including the use of compression gauges, vacuum gauges and exhaust gas analysers; reduction gearing, types and application; piston engines accessory identification; engine exhaust systems, engine controls; exhaust and combustion type aircraft heaters, cold weather operation, engine heating

Jet Propulsion

History of jet propulsion, review principle of propulsion and engine classification, engine types in detail, performance comparison of turbine and piston engines; engine air pressure, velocity and temperature; detailed study of engine components including compressors, burners, combustion chambers, turbines, nozzles and rear units; thrust reversing, silencing and afterburning; fuel and fuel control; jet engine lubrication; types of starters, starting and running procedures; engine performance, effect of water injection and water-methanol injection

AIRCRAFT

Grade 12

Aerodynamics

Theory

Definitions and examples of terms and quantities necessary for the study of aerodynamics: aeronautics, mechanics, dynamics, fluids, motion, Newton's three laws, equilibrium, inertia, weight, mass, force, momentum, speed, velocity, acceleration; equations of motion and their derivation, acceleration due to gravity, terminal velocity, slug (a unit of mass), centripetal and centrifugal force, work, energy, potential energy, kinetic energy, power, horsepower

The atmosphere: pressure - units and conversions; temperature - units and conversions; tropopause, troposphere, stratosphere, International Standard Atmosphere, absolute temperature (Kelvin), Boyle's law, Charles' law, density calculations

Resistance to airflow, form drag, skin friction, Bernoulli's Theorem, Krell gauge; wind tunnel types - open jet, closed jet, open return, closed return; wind tunnel balance, lift and drag formulae; airfoil characteristic curves - lift and drag coefficient, lift-drag ratio, centre of pressure; stalling angle, angle of incidence and loading

Practical

Problems dealing with above terms

Wind tunnel experiments on airfoil models with plotting of characteristic curves

AIRCRAFT

Grade 12

Electricity

Magnetos

Construction and principle of operation of rotating armature, rotating magnet, polar inductor and impulse magnetos. Dismantling and assembling the former. Adjusting breaker points, internally timing, operating and timing to an engine

General

Trouble shooting ignition systems, use of ignition analyzers and harness testers, construction of shielded and unshielded ignition harness assemblies. Types of circuits used in lighting, precautions necessary in wiring aircraft. Purpose, location and operation of relays; application of motor-generator units to generate A.C. of various frequencies. Construction, operation and demonstration of alternators and jet ignition systems

Starters and Generators

Construction, operation and comparison of starter and generator circuits. The dismantling, overhauling, assembling and testing of these machines; construction, operation, function and adjustment of generator controls of the vibrating and carbon pile types

AIRCRAFT

Grade 12

Sheet Metal

Heat treatment of aluminum alloy sheets and rivets, types of ovens and baths used and their heat control, heat treating processes, calculation of bend allowance, fabrication of metal parts such as spars and ribs, the forming of stringers and air scoops by means of hand and power presses, causes of corrosion, reaction between dissimilar metals; surface protection, cover fastenings and their installation; repairing skin, floats-and cowlings. Operation and care of metal band saws, nibblers, electric shears; form blocks and dies

AIRCRAFT

Grade 12

Welding

General

A study of the gases used; safety measures; construction, care and operation of welding apparatus; flame characteristics; selection of proper welding rod; fluxes used for welding cast iron and bronze; construction and operation of cutting torch

Operations

The preparation of steel for a variety of joints; practice in welding butt and lap joints; fillet welding; manipulation of blow pipe and rod; forward and backward ripple welds on steel; simple tests for fusion, penetration and bead; welding cast iron; welding a cluster tube joint. Practice in the freehand use of cutting torch to layout

AIR CONDITIONING AND REFRIGERATION

Four-Year Programme Grades 9, 10, 11 and 12

Grade 9

SAFETY: Safe practices in the use of tools and equipment should be stressed and observed at all times.

1. Domestic Heating

   (a) History of domestic heating

   (b) Domestic heating systems

2. Space Heaters

   Operating principles

3. Forced Air Heating

   (a) Types of forced air furnaces and application of each type

   (b) Basic components of a forced air furnace and their functions

   (c) Forced air distribution systems - graduated trunk and perimeter; zoning

   (d) Fuels: coal, gas, oil, electricity

4. Hydronic Heating

   (a) History of hot water and steam heating

   (b) Comparison of hot water gravity system, forced hot water and steam heating systems

   (c) The basic components and operating principles of a gravity hot water system, a forced hot water system and a steam heating system

   (d) Zoning in a forced hydronic system

5. Heat Loss

   Heat and indoor comfort; how heat travels - conduction, convection and radiation; how a room loses heat

6. Heat Loss Calculations

   Thermal resistance, the U factor of walls, ceiling, window glass, doors and floor. Calculating the heat loss of a room and selecting the proper size of heating unit

7. Heat Gain

   Survey of heat sources; room orientation; construction of walls, roof, ceiling, floor and windows; shading, exhaust and vents; occupants and utilities

8. Calculation of Heat Gain

The U factor of walls, roof, windows and doors. The heat gain of a room and the selection of a suitable cooling unit

9. Refrigeration Fundamentals

Application of refrigeration in the home and industry; how heat is transferred in solids, liquids and gases; the B.T.U., specific heat, specific heat tables; the difference between B.T.U.'s and temperature; the meaning of sensible heat; determining the amount of heat involved in a given temperature change

10. Changes in State of Matter

(a) Vapour: definition, meaning of saturated vapour and superheated vapour

(b) Pressure: definition, meaning of absolute pressure, gauge pressure and vacuum

(c) Comparison of condensation and evaporation; use of tables to calculate the B.T.U.'s involved in evaporation and condensation

11. The Refrigeration Cycle

The refrigeration system - parts and their purpose; the pressure cycle, the temperature cycle, the heat cycle, the liquid-vapour cycle; the purpose and results of evaporation in the refrigeration cycle. Fahrenheit, Celsius and Absolute temperature scales; pressure - temperature relationship. The standard ton rating

12. Working with Copper Tubing

(a) Safety: safe procedures in the use of hand and power tools

(b) Location of holes for tubing in relation to the building structure

(c) Cutting, Reaming and Flaring: cutting, reaming and flaring tools; reaming and flaring hard and soft tubing; safety precautions; flare fittings

(d) Swaging: application; sizes and types of swaging tools; direction of flow through swaged joints

(e) Pinching-off Tubing: types of pinch-off tools; technique of pinching off and sealing tubing; re-sizing tubing

(f) Bending: types of benders and precautions for their use, application, location of bends

(g) Soldering: preparation; soldering fluxes; soft soldered joints; silver soldering and brazing; silver soldering using dry nitrogen

(h) Refacing flare fittings; refinishing

Grade 10

Air Heating Equipment

SAFETY: Safe practices in the use of tools and such equipment as acetylene cylinders, refrigerant cylinders and gauges should be stressed and periodically reviewed.

1. Space Heaters

   (a) A study of the types and models

   (b) Oil burning: vaporizing pot type, components and their functions

   (c) Gas burning: models for natural and manufactured gas, vented and unvented; safety controls

2. Forced Air Furnaces

   The purpose, design features and construction of combustion chambers, heat exchangers, fans, filters (mechanical and electrostatic), registers, grilles, humidifiers and humistats for oil burning, gas burning and electric resistance, forced air furnaces

3. Hydronic Heating

   (a) The meaning of loss of head and available head

   (b) Boilers: pressures, ratings, size, B.T.U. output in relation to horsepower; construction features; fuels used; basic components and their purposes; combustion and boiler efficiency

   (c) Line sizing: the resistance to flow of pipes and fittings; determining the size of lines and fittings

   (d) Pumps, valves and traps: types, sizes, ratings and application

   (e) Controls: operating principles of the basic controls for gas and oil fired boilers; the cycle of operations for a boiler

   (f) Radiant heating: ceiling and floor installations; the design of a typical radiant heated home or building; the size and spacing of tubing; balancing cocks and air vents

   (g) Practical work: cutting and soldering copper pipe; types and installation of pipe fittings; tube and pipe bending; cutting and threading steel pipe; brazing

Air Conditioning

1. Heat and Heat Loss

   (a) Humidity: the effect and control of moisture; relative humidity, dew point, wet and dry bulb temperature, vapour barrier; humidification

   (b) Thermal conductance and thermal resistance for typical home construction

2. Heat Loss Calculations

(a) Typical floor plan and use of charts to determine the U values

(b) Meaning of such terms as temperature, B.T.U., heat flow, heat transmission factor and heat loss multiplier

(c) Calculation of the total heat loss for a small house by an approved method

3. Heat Gain

Meaning and terminology; heat and heat gain - sensible heat, latent heat, external and internal sources of heat; factors affecting heat gain - humidity, ventilation, shading and solar shielding; heat transmission - building construction and compass direction

4. Calculation of Heat Gain

(a) Typical floor plans and use of charts

(b) Determination of the total B.T.U.H. gain

(c) Selection of suitable cooling equipment for the structure

Refrigeration

SAFETY: Safe practices in the storing and handling of refrigerants should be emphasized and reviewed from time to time.

1. Handling Refrigerants

Refrigerant cylinders: colour coding of cylinders, types; proper storage and handling; safety devices and shipping regulations; storing refrigerants; safety precautions

2. Refrigerants and their Characteristics

Purpose and properties of a refrigerant; refrigerant tables; common refrigerants - water, ammonia, R11, R12, R22 and R114, R500 and other refrigerants; common and chemical names and formulae; symbols; reaction of refrigerants with moisture

3. Leaks in a Refrigeration System

Chemical reaction of a refrigerant with flame and the precautions to be observed when a refrigerant comes in contact with flame; method of testing for refrigerant leaks and the equipment used

4. Installing and Reading Gauges

Types of gauges and the application of each type; types of thermometers, their purpose and use; proper use of electrical test instruments

5. Adding Refrigerant to a System

Safety precautions; reason for and method of adding refrigerant; when refrigerant is added in vapour and liquid forms; reason for and method of purging air from the system

6. Low and High Side Float Systems

Construction features and principles of operation; technique of testing for proper operation; capillary lines

7. Moisture and Oil Accumulation

Effects of moisture and oil accumulation; effects of desiccants and dryers and their application; selection of suitable desiccants and dryers

8. Servicing the Unit

The effect of refrigerant shortage and the technique of testing for proper charge; checking for acid damage to needle valves and float bulbs; checking voltage, current and power of the motor; dismantling, cleaning, checking and re-assembling the unit

Grade 11

SAFETY: Proper safety precautions in the handling of refrigerants, welding and power equipment should be emphasized and observed.

1. Heating Control Equipment

The purpose, design features, construction, installation and application of the thermostat, protectorelay ignition transformer, delayed action oil valve, barometric draft controls, pilot generator, series gas valves and equivalent controls

2. Heating Control

Factors necessitating zone control; effects of zoning on equipment size; controls for zone heating (automatic modulating dampers) fuel and power savings; the lowering of the thermostat at night for fuel savings

Boilers

1. Types of Boilers

(a) Classification according to design and fuels burned

(b) Comparison of steel and cast iron boilers, rating of boilers

(c) Design features, heat transfer and types of heating surfaces

2. Boiler Operation

(a) Water level; water supply and water treatment; purpose, size and location of expansion tank

(b) Operating pressure, controls and safety equipment

(c) Efficiency; testing for carbon dioxide

(d) Inspection and codes

(e) Boiler troubles - water, vacuum, venting

Air Conditioning

1. The Design of a Warm Air Heating System for a Small House - Perimeter System

(a) Use of the equal friction method

(b) Selection of the type of heating equipment

(c) Determination of the location and size of the supply outlets, the return inlets and the ducts

(d) Calculating total C.F.M. requirements

(e) Layout of the heating plan using standard symbols and with detailed specifications

2. The Design of a Summer Cooling System for a Small House

(a) Types of systems: loop, radial and extended plenum perimeter, overhead trunk and radial

(b) Determining the locations and size of the supply outlets, branch inlets and the ducts; the use of the supply duct table

(c) Calculating the total C.F.M. requirements, duct charts and their application

(d) Layout of the cooling plan using standard symbols with detailed specifications

Refrigeration

1. Evaporators

The purpose, principle and requirements of an evaporator; types of evaporators; circulation in evaporators; oil return, oil traps, accumulators; velocity of vapour through evaporator

2. Reciprocating, Rotary and Centrifugal Compressors

Purpose, principles and operating pressures; size of units and horsepower required; lubrication and servicing

3. Servicing Compressors

The use of exploded and cut-away views to show parts and construction details; removal of compressor from condensing unit, safety precautions to observe when lifting; removing and replacing flywheel, compressor head and valve plate; types and purpose of seals; removing and replacing seals; disassembling, lubricating and re-assembling reciprocating, rotary and centrifugal compressors; marking mating parts; making gaskets; connecting compressor to condensing unit and testing for satisfactory operation

4. Hermetic and Semi-hermetic Units

The development of hermetic units; types of compressors used; types of metering devices; vapour cooling; effect of moisture in sealed units; servicing sealed units. Relays and capacitors required for starting sealed units

5. Refrigeration Controls and Control Valves

The principle, construction, installation, application and servicing or replacing of low pressure controls, temperature controls, high pressure cut-outs, solenoid valves, constant pressure valves, water regulating valves and pressure relief valves

6. Fuel Oils

   (a) Commercial methods of classifying fuel oils

   (b) Specific gravity, flash point, viscosity, pour point, end point, B.T.U. rating

   (c) The relationship between these qualities and combustion

7. Combustion

   (a) The chemistry and physics of combustion (basic principles)

   (b) The flame: its structure, size and colour

   (c) Products of combustion - testing for carbon dioxide

   (d) Incomplete combustion and its effects on operating efficiency

   (e) Heat: physical and chemical explanation

   (f) Measurement of heat and temperature - B.T.U.'s and degrees

8. Oil Burners

   (a) Gun Type: design features and characteristics of high and low pressure types

   (b) Rotary Burners: vertical and horizontal types, design features and characteristics of each

   (c) Vaporizing or Pot Type Burner: design features and characteristics

   (d) Design features of pumps, pressure regulating valves, nozzles, fans, air control devices, ignition system, and combustion chambers

9. Burner Service

   (a) High Pressure Gun Type: service problems, servicing single and two stage pumps, ignition and combustion problems

   (b) Low Pressure Gun Type: service problems

   (c) Rotary Burner Service: typical problems and their solution

   (d) Vaporizing Burner Service: service problems

Grade 12

SAFETY: The care and proper use of tools, refrigeration equipment and test equipment should be stressed. Proper precautions should be observed in the handling and servicing of refrigeration equipment.

1. Air Movement Testing Procedure

Measuring air pressure in ducts; the relation of static pressure and velocity; the use of dampers in branch ducts; types of centrifugal fans used in air conditioning

Air Conditioning

1. Commercial Heat Loss Calculation

Difference between domestic and commercial heat loss calculation; determination of the design temperature difference; the type of construction and exposure; calculation of the B.T.U. loss per hour for the building considering all the factors - include ventilation loss, occupancy load and appliances; determining the total heat loss of the building

2. Commercial Air Conditioning

(a) Making a survey of all the factors affecting the cooling problem e.g., types of construction, exposure, appliance and occupancy load, space to be cooled, window and door areas and outside air for ventilation

(b) Application and use of psychrometric and comfort charts

(c) Calculation of the cooling load considering all the factors involved

(d) Selection of the size of equipment and ducts necessary to give the required cooling

3. Water and Air Cooled Condensers

Purpose of condensers; water supply, water conservation, types of cooling towers; special features and operating principles of double pipe, evaporative and air cooled condensers

4. Liquid Receivers

The purpose, application, types, construction, safety devices, piping and servicing of liquid receivers

5. Purgers

The purpose, types, construction, application and servicing of purgers

6. Defrosting Evaporators

The purpose, principles and application of simple defrost, automatic electric defrosting, hot gas defrosting and water spray defrosting systems

7. Refrigerated Enclosures

Types, purpose and importance of insulation and vapour barriers; methods of constructing refrigerated enclosures - heat calculations

8. Compressor Calculations

Use of refrigerant tables; calculating compressor size and horsepower; effect of pressures and temperatures; standard ton condition

9. Ultra Low Temperature Systems

The design features, operating principle and method of applying the two stage and cascade systems

10. Calculating Size of Refrigerant Lines

Allowable velocities and pressure drops in pipes; effect of pressure drops; sizing pipes by velocity and by pressure drop; effect of changing conditions of flow

11. Brine in Refrigeration

Meaning of indirect system, brine chemistry, the eutectic point, corrosive properties of calcium chloride and sodium chloride, determination of the Ph value

12. Multiple and Complete Systems

Principle and application of ice cube makers, and "flake ice" makers

13. Absorption Systems

The principle and application of household (domestic) and industrial absorption systems. The operating cycle of the industrial ammonia absorption system and the principle of operation of the Lithium Bromide System

14. Heat Pumps or Reverse Cycle Systems

The purpose, theory of operation and performance of heat pumps; sources of heat; B.T.U. capacity; calculating the size of lines; types of control and reverse valves; auxiliary heating

15. Recent developments in air conditioning and refrigeration

Fans

1. Axial Flow and Propeller Type Fans

Types, uses, nomenclature of various models, characteristics, comparison of axial flow and propeller type fans; testing

2. Centrifugal Fans

The three classifications, forward, straight or radial and backward curved blades, characteristics of each, performance curves, comparison of the performance of each type

3. Fan Laws

Relationship between: volume and speed, pressure and speed; power requirements, brake horsepower; total pressure, static pressure, velocity pressure

4. Blowing Versus Exhausting

Comparison between blowing and exhausting in low and high pressure systems

5. Servicing Oil Burner Parts

(a) Pump problems and their solution; use of pressure and vacuum gauges; replacing defective parts

(b) Servicing pressure regulating valves of various types; use of a trouble chart; adjustments

(c) Nozzle problems

(d) Air delivery problems

6. Servicing Complete Oil Burner Systems

Locating and diagnosing service problems in completely installed and operating systems

7. Testing Combustion Efficiency

A study of the purpose and use of a stack thermometer, a draft gauge, carbon dioxide testing equipment; analysis of flue gases

Gas Furnaces

1. Combustion

The chemistry and characteristics of natural, manufactured, butane and propane gases; the cost, storage and availability of the above gases; air requirements for combustion; the chemistry of combustion; flues: size, construction, condensation problems

2. Controls and Servicing

Control system voltages in common use; circuits and controls used; operating principles of controls; use of electrical instruments for making electrical tests and measurements; testing controls for trouble; making the necessary repairs or replacing the defective control

3. Servicing Gas Furnaces

Selecting the proper size of feed pipe and orifice for satisfactory operation; testing for carbon dioxide and adjusting primary and secondary air; diagnosing and correcting common gas furnace troubles such as extinction noises, flashback, resonance and flame floating

APPLIED ELECTRICITY

Four-Year Programme Grades 9, 10, 11 and 12

Grade 9

SAFETY: Safe practices and the recognition of electrical hazards should be emphasized and periodically reviewed.

1. Circuits

   (a) Study and construct signal circuits observing the effects of series and parallel loads of lamps, bells and buzzers; drawing schematic diagrams using standard symbols - use dry cells and a bell ringing transformer as voltage supplies; tracing and checking the wiring against the schematic diagram before operating

   (b) Locating and repairing circuit faults

   (c) Construction and application of lamp and appliance cords (2-3 wire)

2. Electrical Connections

   (a) The construction of simple joints such as rat-tail, tee and western union

   (b) Soldering: preparation of the soldering iron; soldering fluxes; composition of solder; soldering wire joints

   (c) Taping and weatherproofing

   (d) Solderless connectors

3. Magnetism

   (a) The study of the properties of magnets and of lines of force using filings and compasses; magnetic and non-magnetic materials

   (b) The law of magnetic attraction and repulsion; a theory of magnetism

   (c) The earth as a magnet

   (d) Common types of magnets and their uses

   (e) Methods of magnetizing and demagnetizing

   (f) Magnetic shielding

4. Electro-magnetism (Hand rules are to be introduced as required)

   (a) Examination of the field of force about a single wire carrying a current

   (b) Making an electro-magnet

   (c) A study of the magnetic field of a coil and its polarity

   (d) Applications of electro-magnetism

   (e) The study of the principle of operation and the repair of electric bells, buzzers, annunciators and allied equipment

5. Conductors and Insulators

An experimental study of a few common metals and non-metals as a basis for classification into conductors and insulators. Semi-conductors should be introduced

6. Sources and Effects of Electricity

(a) Basic methods of producing E.M.F.: friction, thermal, chemical, electromagnetic induction, photovoltaic and piezoelectric

(b) Demonstrations and application of the above methods

(c) Series and parallel cell connections

(d) A study of the basic effects of electricity

7. Electrical Units

(a) An experimental study to provide a general understanding of electrical pressure, resistance and current and the relationship between them. Conventional flow and electron flow are to be presented

(b) Meaning of electrical power and energy; units of measurement

(c) The reading of a kilowatt-hour meter and the calculation of a simple energy bill

8. Circuit Protection

Construction, purpose, operation and rating of simple fuses (plug and cartridge types); an experiment to show the protective value of the fuse with application to the circuits in the home

Grade 10

A. Installation and Maintenance

All electrical installations should conform to the requirements of the Hydro-Electric Power Commission of Ontario and the local Supply Authority.

SAFETY: Stress safe practices in the use of tools and equipment and for the prevention of electrical shock.

1. Splices and Joints

Proper construction of joints used in lighting circuits. A further study of solderless connectors

2. Materials

The study of the American wire gauge and wire table; the recognition of common wires and cables according to size, insulation and use; the identification by name, size and description of other trade materials within the scope of this course

3. Circuits

   (a) Further study of signal systems to include the annunciator and the following systems: the apartment door lock, return call, burglar alarm and master control; simple telephone circuits

   (b) Typical circuits as used in an average-size residence; construction in non-metallic sheathed cable; architectural plans and symbols

   (c) The testing of circuits with a voltage tester and a voltmeter and the repair of circuit faults should be introduced as required

   (d) The construction and testing of simple electronic circuits such as a rectifier and a triode amplifier

4. Circuit Protection

   The construction, purpose, operation and rating of circuit breakers and special fuses

5. Elementary Testing and Repair

   The testing of simple domestic electrical appliances and devices using a test lamp and an ohmmeter; making minor repairs; checking for adequate insulation by means of a "megger" or equivalent testing instrument after the repair has been made and before returning the device to service

B. Theory and Test

Problems on the topics studied should be assigned in a systematic manner to clarify and drill the principles involved.

SAFETY: Good safety practices should be stressed.

1. Electro-magnetism

   (a) Plotting the field of force about a single conductor carrying current A review of the hand rule

   (b) A study of the magnetic flux around two adjacent parallel conductors carrying current in the same direction and in opposite directions

   (c) Plotting the magnetic field set up by an energized single layer coil with an air core; include the lines of force around the individual conductors. A review of the hand rule

   (d) A study of the three factors affecting the strength of an electro-magnet

   (e) Applications of electro-magnetism such as door chimes, relays, lifting magnets, circuit breakers and magnetic contactors

   (f) An elementary study of magnetomotive force, magnetic flux, reluctance, flux density and permeability

2. Conductors, Semi-Conductors and Insulators

   Definitions. A more advanced study and experimental determination of the ability of metals, non-metals and solutions to conduct current

The Bohr theory of atomic structure; explanation of conducting properties of conductors, semi-conductors and insulators based on the theory of atomic structures; elementary electrostatics

3. Types of Electric Current

An introductory study of unidirectional current (steady and pulsating) and alternating current; the meaning of electrical cycle and frequency

4. Instruments

(a) Ammeters and voltmeters: circuit connections; precautions for their use; accurate scale reading

(b) Using an ohmmeter

5. Ohm's Law (Experimental study)

(a) The effect on the current in a circuit produced by varying the resistance and maintaining a constant applied emf.

(b) The effect on the current in a circuit produced by varying the applied emf. and maintaining a constant circuit resistance

(c) Development and application of equations

(d) Introduction to prefixes

6. Resistors, Resistance Measurement, Circular Mil Measures

(a) An examination and study of the resistance materials used in such household appliances as lamps and heaters

(b) Comparison of wire diameters using the American standard wire gauge and wire tables; comparison of mil-foot resistances of wires in common use

(c) Calculation of the resistance of a round conductor based upon physical factors

(d) Resistors: common types; construction; ohmic and power ratings; application

7. Analysis of Electrical Circuits

Determination of current, voltage and resistance characteristics of typical series, parallel and series-parallel circuits

8. Power and Energy

(a) Definitions and units of power and energy

(b) Voltmeter-ammeter and wattmeter methods of power measurement; energy measurement by the watt-hour meter

(c) Calculating power and energy; horsepower in terms of watts and kilowatts

9. Voltage Drop and Power Loss

Measurement of voltage drop and calculation of power loss in electric circuits

10. Electronics

(a) Physical examination of: resistors, capacitors, inductors, electron tubes, transistors

(b) Colour codes for resistors

(c) Simple diode experiments to demonstrate emission and unidirectional flow; rectification

(d) Simple triode experiments to demonstrate grid control of anode current; amplification

Grade 11

A. Installation and Maintenance

All electrical installations should conform to the requirements of the Hydro-Electric Power Commission of Ontario and the local Supply Authority.

SAFETY: Electrical safety should be stressed.

1. Circuits

(a) The installation of electric services; more advanced study of circuits for domestic light, heat and power, using non-metallic and metallic cable, E.M.T. and rigid conduit

(b) Planning and estimating electrical installations from blueprints and circuit diagrams

(c) The installation of D.C. motors using different types of starters and protective devices common to industry

(d) The connection, reversal and simple control of A.C. fractional horsepower motors

(e) The further study of cable splices, lugs and connectors as applied to 1(a), (c) and (d)

(f) An elementary study of D.C. motor speed control

2. Maintenance

(a) The testing and repair of circuits used for light, heat and power

(b) The maintenance, testing and repair of motors, generators and industrial control equipment

(c) The testing and repair of major appliances including electrical heating units, oil furnace controls, ranges, water heaters and other common equipment

(d) The care and maintenance of storage batteries

3. Lighting

An introductory study of lighting and lighting fixtures

4. Industrial Electronics

A study of the applications in industrial control of those items chosen for study in Elementary Electronics (See Part B, Theory and Test, Section 10)

5. Optional Topics

(a) Motor rewinding

(b) Electric heating

B. Theory and Test

Problems on the topics studied should be assigned in a systematic manner to clarify and drill the principles involved.

SAFETY: Good safety practices should be stressed.

1. Electro-magnetism

(a) The magnetic circuit; the relationships between the magnetomotive force, flux and reluctance; flux density; formulae; C.G.S. or M.K.S. system of magnetic units

(b) A study of the magnetizing curves for cast iron and commercial grades of core materials

(c) Series magnetic circuits involving various materials and air gaps; problems

(d) Practical applications of electro-magnets

2. Insulation

Properties of insulating materials such as rubber, varnishes, plastic compounds, impregnated paper, varnished cloth, tapes, asbestos and silk

3. Resistors and Resistance Measurements

(a) An examination and study of resistors used in industrial control apparatus

(b) Measuring the resistance of resistors connected in series and in parallel and combinations of both; methods and formulae for determining the combined resistance; problems

(c) Electrical conductance; problems

(d) Kirchhoff's Laws - the solution of electrical networks using Kirchhoff's Laws

4. Electrical Measurements

Note: The proper use and care of instruments should be stressed.

(a) The D'Arsonval galvanometer: parts, principle of operation and its application in the voltmeter, ammeter and ohmmeter

(b) Bridge circuits: the Wheatstone bridge and the slide wire bridge

(c) Power measurement: the construction and principle of operation of a wattmeter; proper wattmeter connections; measurement of power

5. D.C. Generators

(a) The direction and magnitude of the emfs induced in conductors cutting a magnetic field; formulae, problems

(b) D.C. Generators: parts and their functions; types and connections; self and separate excitation; factors affecting generated voltage; the building up of a shunt generator; commutation; armature reaction and commutating poles

(c) Generator characteristics: the saturation curve; the load or external characteristics of a separately excited generator; the load or external characteristics of a self-excited shunt generator and compound generators; voltage regulation; losses in D.C. generators; efficiency

(d) Generator selection for specific applications

(e) Parallel operation of shunt and compound generators (optional)

6. D.C. Motors

(a) Principle, types and connections; parts and their functions

(b) Counter emf., manual motor starters, methods of speed control, reversing D.C. motors, automatic starters; dynamic braking

(c) Load characteristic curves of shunt, series and compound motors; speed regulation; armature reaction and interpoles

(d) Interpretation of motor control schematic diagrams; operating sequence

(e) Losses in motors and efficiency; calculations

(f) Motor selection for specific applications

7. Alternating Current

(a) An introductory study of alternating emf. generation, the sine wave, frequency, drawing the sine wave; average, effective and maximum values

(b) Inductance: definition, factors affecting inductance and inductive reactance, formulae and units; phase relationships; non-inductive windings; inductors in series and parallel; application

(c) Capacitance: definition; types, construction and principle of capacitors; factors affecting capacitance and capacitive reactance; formulae and units; phase relationships; capacitors in series and parallel; application

(d) Simple A.C. circuits, phase relationships, Ohm's Law A.C., impedance

(e) Vector diagrams for A.C. series circuits

(f) Time constants

(g) Non-sinusoidal wave forms and pulses (briefly)

8. Transformers

    (a) Principle, construction, types and application

    (b) Turns, voltage, current and impedance ratios

9. Relays

    Principle, construction, types and application

10. Elementary Electronics

    Refer to Grade 11 Electronics. The topics selected and studied will depend on the time and equipment available. This section is to be deleted if the students receive instruction in the electronics laboratory.

Grade 12

A. Installation and Maintenance

All electrical installations should conform to the requirements of the Hydro-Electric Power Commission of Ontario and the local Supply Authority.

SAFETY: Safe practices in the use of electricity should be stressed.

1. Circuits

    (a) The installation of distribution systems in non-metallic and metallic cable, E.M.T. and rigid conduit for light, heat and power as used in modern apartment buildings and small factories. Services should be included. This study should include plans, bills of material, estimates and circuit diagrams

    (b) A study of controllers and time-delay starters for D.C. motors; dynamic braking

    (c) The installation of the common types of single phase and polyphase A.C. motors using different types of starters, control apparatus and protective devices common to industry

    (d) Interpretation of motor control schematic diagrams - operating sequence

    (e) The study of the mounting and connecting of transformers and other heavy apparatus. Instruction is to be given in anchoring devices, the tools required, and in the use of supports such as hangers and brackets. The grounding and bonding of equipment is to be emphasized.

2. Maintenance

    (a) Further testing and repair of circuits for lighting and power equipment, e.g. tests for continuity, intermittent and high resistance connections, short circuits and grounds

    (b) Maintenance, testing and repair of rotating equipment, transformers, control apparatus and other electrical devices

3. Industrial Electronics

    The installation, testing and repair of electronic controls such as used in industrial equipment

B. Theory and Test

Problems on the topics studied should be assigned in a systematic manner to clarify and drill the principles involved.

SAFETY: Safety precautions should be stressed.

1. The Sine Wave
    - (a) Definition and construction of the sine wave; cycle, frequency
    - (b) Average, effective (R.M.S.) and maximum values and the relationships between them; form factor of the sine wave
    - (c) Equation of the sine wave, instantaneous values
2. Alternating Current Circuits
    - (a) Review of inductance, capacitance, reactance and impedance
    - (b) Application of Ohm's Law to series and parallel alternating current circuits
    - (c) Phase relationships in A.C. series and parallel circuits, active and reactive components, vector diagrams
    - (d) Power waves for circuits containing R, L, or C; frequency of power waves; positive and negative power; instantaneous, maximum and average power; effect of phase angle
    - (e) Power and power factor; definitions; meaning of leading and lagging power factor; measurement of power in non-inductive, inductive and capacitive single phase circuits; determination of power factor; relationship between volt-amps, watts and vars; formulae and calculations of power and power factor
    - (f) Power factor correction by capacitors
    - (g) Series and parallel resonance: characteristics of resonant circuits; resonance curves
3. Polyphase Systems
    - (a) Reasons for polyphase systems; elementary two phase and three phase alternators; star and delta connections
    - (b) Vector diagrams for balanced loads in star and delta: unity p.f. and lagging p.f.
    - (c) Calculation and measurement of three phase power (balanced loads) by various methods
4. Alternating Current Generators - Alternators
    - (a) Construction of single and polyphase alternators, factors affecting voltage and frequency
    - (b) Voltage control, voltage regulators, voltage regulation for resistive, inductive and capacitive loads, armature reaction, vector diagrams

Optional(c) Parallel operation of alternators, synchronizing by use of lamps and voltmeters, load adjustment between machines, effect of changing field excitation, hunting

5. Transformers

(a) Construction, principle, voltage ratio, transformer equation, effect of loading a transformer, efficiency and commercial applications

(b) Polarity: definition, determination and importance

(c) Transformer connections: series, parallel, star, delta, Scott, open delta, three phase to six phase

(d) Load characteristics, losses and efficiency

(e) Instrument transformers principle and connections; safety precautions

(f) Transformer vector diagram (Optional)

6. Alternating Current Motors

(a) Explanation and demonstration of the revolving magnetic field, synchronous speed

(b) Three-phase squirrel-cage induction motors: the principle, construction and commercial uses; a study of torque, slip, rotor speed and rotor frequency, starting current, starting torque, power factor and the operating or load characteristics

(c) Three-phase wound rotor induction motors: the principle, construction, torque, slip, rotor speed and rotor frequency, starting current, starting torque, power factor, speed control and operating or load characteristics; commercial uses

(d) Comparison of squirrel cage and wound rotor induction motors

(e) Single phase A.C. motors: the principle, construction and application of single phase A.C. motors; a study of special starting devices, arrangement of windings, starting currents, torque and speed characteristics, power factor and efficiency

(f) Synchronous motors: the principle, construction and commercial uses of synchronous motors including a study of starting methods, speed characteristics, power factor and power factor correction; characteristic curves and efficiency

(g) Motor control: the principles and types of starting and control devices in common use for induction and synchronous motors

(h) Motor selection for specific applications

7. Instruments

Note: The proper use and care of instruments should be stressed.

The theory of operation, use and proper circuit connections for ammeters, voltmeters, wattmeters, watt-hour meters, maximum demand meters, oscilloscopes, impedance bridges, vacuum tube voltmeters and insulation testers

8. Industrial Electronics

Note: The following topics should be taught in the Electronics Laboratory if there is one in the school and it is available otherwise the instruction may be given in the Electrical Laboratory or Electric Shop.

The depth of study will depend on the time and equipment available.

(a) Power rectifiers

The construction, theory of operation, characteristics and precautions to observe when gaseous, selenium, silicon and controlled solid state rectifiers are used commercially in single and polyphase circuits; applications

(b) Photo sensitive devices

Construction, principle of operation and application of photo-emissive, photo-voltaic and photo-conductive components; applications in counting, sorting, grading, measuring within limits and quality control

(c) Electronic timers

The time constant principle; the thermal principle; industrial applications e.g. welding control

(d) Industrial electric heating

Principles and application of induction, dielectric and infra-red heating

(e) Magnetic devices

Construction, operating principles and applications of saturable reactors and tape recorders

(f) Computers (Elementary study) (Optional)

Mechanical and electronic forms of digital and analogue computers; computer logic - binary system; block diagram of elementary digital and analogue computers; application of each type

(g) Servomechanisms (Optional)

The study of synchros (selsyns) as motors, generators and differential units; a servomechanism defined as a closed loop system; servo block diagram; analysis of a typical industrial servo system, such as motor speed or generator output control system

9. Lighting (Domestic, Industrial and Display) (Optional)

(a) Adequate lighting requirements, minimum standards for different applications

(b) Lighting units and their meaning, lighting types

(c) Lighting control and equipment

APPLIED ELECTRONICS

Four-Year Programme Grades 11 and 12

Grade 11

SAFETY: Safe practices in the handling of electrical and electronic equipment should be stressed.

A. Theory and Test

Symbols, both communications and industrial, and methods of establishing correct operating voltages should be introduced as required.

Review Ohm's Law; series and parallel circuits, Kirchhoff's Laws; power and energy.

1. Vacuum Tubes

   (a) Introduction to electron emission - consideration of electron emitting materials

   (b) The diode: construction and testing of standard two element (diode) vacuum tube; the effect of cathode temperature change on plate current; the effect of plate voltage change on plate current; application of the diode as a rectifier; effect of load resistance on output; plotting characteristic curves and calculation of D.C. plate resistance

   (c) The triode: the control action of a grid placed between the cathode and the plate; grid voltage, plate current and plate voltage; charactertistic curves. The use of characteristic curves to determine amplification factor, A.C. plate resistance, mutual conductance and gain; operation as an amplifier and as a control device for relay operation; comparison of directly and indirectly heated cathodes

   (d) Multi-element tubes: reasons for development; interelectrode capacitance; secondary emission

2. Electrostatics

   Separation of electric charges, their attraction and repulsion; the electron theory and its application to static charges; charging by induction; distribution of charges on a material; stress lines between charged bodies; discharge from points as compared to spheres; electrostatic screening; storage of charge as in a capacitor

3. Semi-Conductors

   Structure of matter; the Bohr atom, introduction to energy levels and their relationship to conductors, insulators and semi-conductors; conduction through solids, liquids, vacuum and gases; P and N type semi-conductor materials

4. Alternating Current (Qualitative consideration only)

   (a) Generation of alternating emf; the sine wave; cycle; frequency; harmonics; the frequency spectrum; amplitude; effective, average, instantaneous, peak and peak-to-peak values; introduction to vectors

(b) Electro-magnetic induction

(c) The transformer: principle and construction; types and application; turns, voltage, current and impedance ratios

(d) The capacitor: types, construction, operation and application; the factors affecting the capacitance; reactance change with frequency; phase relationships for V and I; capacitors in series and parallel

(e) The coil: types, construction, operation and application; self inductance; factors affecting inductance and reactance; phase relationships for V and I; non-inductive windings; inductors in series and parallel

(f) R, L and C in series and parallel on A.C., series and parallel resonance, tuned circuits; the Q of L-C circuits; L/C ratio; typical resonance curves

5. Circuit Elements

(a) Power supplies: half- and full-wave rectifiers; voltage doublers; methods of obtaining bias voltages from a power supply; the bleeder resistor and reasons for its use; voltage dividers

Filter circuits: choke input; capacitor input; R-C filters; characteristics of each type

(b) Microphones: principle, construction and application of carbon, crystal and dynamic microphones

(c) Audio amplifiers: classes of operation; transformer, resistance and direct-coupled amplifiers; volume control; D.B. Gain

(d) R.F. amplifiers: the use of tuned-grid and tuned-plate circuits and the gain obtained thereby; precautions necessary to avoid undesirable feedback

(e) Amplifier characteristics: comparison of amplifier types; frequency response curves; factors affecting frequency response; choke-coupled, resistance-coupled and direct-coupled amplifiers; comparison of solid state and vacuum tube amplifiers

(f) Tone compensating circuits for controlling the frequency response of audio amplifiers

(g) Solid state rectifiers

(h) Detectors

(i) Control circuits: typical circuits to illustrate the application of vacuum tubes and solid state devices to electronic control. e.g. photoelectric relays and time-delay relays

(j) Oscillators: requirements for oscillation; methods of feedback; determination of oscillator frequency; L-C, R-C and crystal controlled oscillator circuits

6. Magnetism

(a) Review of magnetic principles and electro-magnetism

(b) M.K.S. or C.G.S. system of magnetic units

(c) Application of magnetic principles to basic meter movements

7. Test Equipment

Simple A.C. and D.C. meter movements, construction of voltmeters, ammeters, ohmmeters and multimeters. Principle of operation of tube testers, test oscillators and the cathode ray oscilloscopes; the use of test instruments in servicing electronic equipment; the principles of organized test procedure in locating faults; interpreting schematic diagrams

B. Shop Course

1. Bench Work (To be introduced as required)

Note: The care and use of hand tools should be taught as required.

The use of the soldering iron; shaping, cutting and drilling light metal chassis; tapping; typical fastening devices and terminal strips used in electronic work. Standard operations are to be mastered such as reading instruments, grinding twist drills and stripping and cabling wires

2. The Colour Code (To be introduced as required)

Codes for capacitors, resistors, coils and transformers

3. Laboratory Work

(a) The use of standard test instruments such as ohmmeters, voltmeters, milliammeters, V.T.V.M.'s, oscilloscopes and test oscillators

(b) Laboratory Experiments
1. The determination of vacuum tube characteristics
2. The analysis of R.C. and L.C. time constant circuits
3. The effect of the values of the component parts on amplifier gain and frequency response
4. The determination of the characteristics of resonant circuits
5. The use of resonant circuits in the production of A.F. and R.F. oscillations
6. The determination of the characteristics of solid state diodes and three element transistors

(c) Shop Projects (To be integrated with the preceding laboratory experiments)

Construction and testing of the following devices:
1. Power supply circuits
2. Audio amplifier circuits
3. Detector circuits
4. R.F. amplifier circuits
5. Oscillator circuits
6. Interval timer
7. Photoelectric relay

Note 1: The testing of electronic equipment should conform to standard laboratory procedure and to I.E.E.E. specifications where applicable.

Note 2: One of the above shop projects should be built on a printed circuit board if time permits.

Grade 12

SAFETY: The proper handling of the picture tube and the wearing of gloves and goggles should be stressed. An eight inch picture tube should be substituted for the larger sizes when doing any work on television sets. The precautions necessary to avoid high voltage shock and the care necessary in handling chassis should be emphasized.

A. Theory and Test

1. Vacuum Tubes

Further consideration of vacuum tubes:

(a) Characteristic curves of sharp cut-off and remote cut-off tetrodes and pentodes; application of tetrodes and pentodes

(b) Review of vacuum tube theory with emphasis on load line, operating point, load matching, power amplification and voltage amplification

(c) Special purpose tubes: construction and operation of dual purpose tubes, converter tubes, beam power tubes, tuning eye and special rectifiers; the use of vacuum tubes in voltage regulator and voltage multiplier circuits

2. Solid State Devices

(a) Review of the Bohr atom with emphasis on energy levels in semi-conductor materials

(b) Conduction in P and N type materials; P.N. junction, forward and reverse characteristics; Zener effect

(c) Diode power rectifiers and controlled rectifiers for single and polyphase circuits

(d) Transistors: principles, construction, types, advantages and disadvantages in comparison with vacuum tubes; amplifier configurations; introduction to hybrid parameters; application of transistors in amplifiers, voltage regulators and other control circuits

3. The Superheterodyne

(a) The principle of frequency conversion; application of the beat note principle; advantages and disadvantages of the superheterodyne as compared to T.R.F. receivers; mixers, converters and I.F. systems

(b) Special circuits: automatic volume control and q.a.v.c. circuits; phase inversion circuits; inverse feedback circuits; tuning indicators; electronic voltage regulators; methods of connecting a record player to a radio; vibrator power supplies

4. Alternating Current Theory

Advanced quantitative considerations

(a) Inductance: definition, calculations, inductive reactance, inductance and resistance in series, phase relations, impedance, vectors

(b) Capacitance: calculations of capacitor values, capacity and resistance in series, phase relations, impedance, vectors

(c) Frequency-reactance graphs for inductors and capacitors

(d) Inductance, capacitance and resistance in series and parallel; resonance calculations; resonance and selectivity curves

(e) Power factor and its calculation; active and reactive components of the current

(f) High frequency effects; distributed capacity and skin effect

(g) Transient effects on D.C. and A.C.

(h) Filters: high, low, band-pass and band rejection filters; characteristics

(i) Elementary transmission line theory; impedance matching, line impedance

5. Photoelectric Effects

Review and further consideration of the types of photoelectric cells. The construction, operating principles, colour sensitivity, characteristic curves and the application of vacuum, gas filled and solid state photoelectric cells; the photo multiplier tube

6. Test Equipment

(a) The principle and application of vacuum tube voltmeters to alternating current, direct current and high resistance measurements

(b) Thermocouple, hot wire, electrostatic, iron vane, rectifier and dynamometer instruments

(c) The construction and operation of electrostatic and electro-magnetic cathode ray tubes

(d) High voltage supplies for cathode ray tubes in oscilloscopes; methods of control

(e) Sweep circuits for cathode ray oscilloscopes; methods of synchronizing

(f) The use of the electronic switch with a cathode ray oscilloscope

(g) The application of the cathode ray oscilloscope for indicating distortion, measuring gain, timing, checking synchronization, determination of frequency, indicating phase relations; the use of an oscilloscope as a voltmeter and for circuit alignment

(h) Sweep generators; marker generators and other advanced test equipment

(i) Inductance and capacitance bridges

(j) Signal tracing methods of analysis

7. Motor and Generator Characteristics

   (a) D.C. generator principle, D.C. motor principle

   (b) D.C. motor and generator classifications, characteristics and applications

   (c) Alternator principle

   (d) A.C. motors: classifications, characteristics and applications

8. Industrial Electronics

   (a) Gaseous diodes: characteristics, ionization, types of gases, pressure and its effect on firing potential; application as rectifiers, regulators and relaxation oscillators

   (b) Thyratrons:

      (1) Principle of operation; construction and characteristics; comparison with a vacuum triode, noting non-continuous control characteristic of gaseous triodes

      (2) Control of ionization by D.C. amplitude

      (3) The gas triode as a rectifier; controlling the output by varying the potential on the grid and by shifting the phase of the grid voltage

      (4) The gas triode as a controlled oscillator; generating saw tooth waves

   (c) Other devices and control systems:

      (1) The saturable reactor and its application in light dimming and phase shift control circuits

      (2) The peaking transformer and its application

      (3) Industrial control: regulation by gaseous tubes, vacuum tubes and solid state devices; motor control; welding control; generator control; quality control; counting, sorting, grading and measuring within limits

      (4) Magnetic recording devices

      (5) Binary arithmetic and its use in data processing

      (6) Basic principles of digital and analogue computers

9. Television and F.M.

   (a) Principles of television: camera tubes, types and operating principles; scanning methods; production of the television signal; analysis of a composite video signal

   (b) Television receiver: the block diagram; the picture tube; sweep oscillators; pulse shaping circuits; the high voltage power supply; T.V. tuners; wide band I.F. amplifiers; separation of video and audio information in the intercarrier receiver; deflection systems; interlaced scanning; video amplifiers; antenna considerations for T.V. receivers

(c) Closed circuit television used in industry. (Block diagram of a complete camera and monitor system)

(d) Frequency modulation: detectors; advantages of the F.M. system; an elementary F.M. transmitter with emphasis on methods of modulation

10. Transmitters

(a) Circuit analysis of simple A.M. transmitters

(b) Transmitter alignment procedure

(c) Transmitting antenna types, radio wave propagation

(d) Elementary transmission line theory, impedance matching

Optional (e) Radio broadcast studio technique (if time permits and facilities are available)

11. Advanced Audio Consideration (High Fidelity)

(a) Advanced considerations for audio amplifiers including standard I.E.E.E. test procedure

(b) Turntables and drive mechanisms

(c) Phono pickups: types, characteristics and applications, stylus construction and materials, stereo pickup principles

(d) Speakers and enclosures

(e) Tape recording principles

(f) Microphones: high fidelity, types, characteristics and placement

(g) Acoustics, basic concepts and problems encountered in domestic and commercial installations

Optional
12. Microwaves (Elementary study only)

(a) Principles and construction of the klystron, reflex klystron, the magnetron, the travelling wave amplifier, lighthouse and special high frequency tubes and transistors

(b) Resonant cavities: electrical and magnetic fields in resonant cavities; attenuation; impedance matching to a wave guide; propogation of the wave within the wave guide

(c) Antennas: types and methods of matching them to wave guides

(d) Principle of tropospheric propogation

B. Shop and Laboratory Course

Note: It is recommended that at least six of the following topics of the Shop Course be studied.

1. Construction of a superheterodyne tuner with emphasis on the testing of each section in accordance with standard I.E.E.E. specifications
2. Experimental determination of multi-element tube parameters
3. Experimental application of advanced test equipment as in the alignment of television and F.M. receivers
4. Construction and analysis of transistorized amplifiers, oscillators and power supplie
5. Experimental determination of the characteristic curves of transistors; transistor parameters
6. Alignment and test of an R.F. transmitter
7. Experimental analysis of typical industrial circuits to illustrate standard industrial applications
8. Experimental analysis of a television receiver

AUTO BODY REPAIR

Four-Year Programme Grades 9, 10, 11 and 12

Grade 9

Note: For most of the practical work in the course "dead" units may be used but for some exercises cars are required.

1. (a) Introduction to shop and general safety practices. The importance of cleanliness should be emphasized

   (b) Introduction to the history of body construction and repair

   (c) Parts - Examination and study to obtain the names, locations and purposes of principal body parts

   (d) Types of body and frame construction

   (e) Identification of automotive body fastenings such as bolts, nuts, washers, metal screws, spring clips, speed nuts and hog rings

2. Safety Precautions

   (a) Handling gasoline and oils

   (b) Types of fire extinguishers and their application

   (c) Carbon monoxide gas and carbon tetrachloride fumes

   (d) Welding equipment

   (e) Paints and solvents

   (f) Jacks and car stands

3. Tools and Equipment

   (a) Care and use of hand tools common to the auto body repair trade. The use of the electric drill and vibrating sander

   (b) Demonstration of simple power equipment, i.e. jacking and supporting a car on car stands

   (c) Sizes and use of different types of wrenches and sockets

   (d) Types and use of hammers, files, dollies and spoons

4. Lighting Units

   (a) Removing and replacing sealed beam units, automotive lamp bulbs, British and European headlamps, tail lights, parking lights, stop lights, license lamps and dome lights or parts of same

   (b) Adjust sealed beam units

5. Effecting Minor Repairs
   - (a) Metal reaction to simple bending
   - (b) Removing a minor dent and finishing the area - picking and filing
   - (c) Demonstration of metal shrinking; checking with the hand for rippled or dented areas
6. Tinning and Soldering
   - (a) Preparation for tinning
   - (b) Use of torch for soldering
   - (c) Tinning
   - (d) Composition and application of body solder; paddles and their use, common lubricants
   - (e) Finishing soldered area - filing and sanding
7. Cleaning the Car
   - (a) Washing
   - (b) Spot cleaning (tar oil etc.) exterior only
8. Care of Body Finish
   - (a) Types of compound (cleaner) and polish (liquid and paste)
   - (b) Methods of applying; polishing
9. Metals
   - (a) Types and gauges of metals used in automobiles
   - (b) A study of body corrosion and procedures for repairing corroded or rusted sections
10. Removing, Replacing and Servicing Parts

    Remove and replace wiper arms and blades, arm rests, ash trays, small chrome strips, mouldings, name plates, step plates, kick pads, trunk linings, rear seats, rear floor mats, inside door handles, regulator handles and bumpers
11. Refinishing - Enamel
    - (a) Types of sand papers and their proper use
    - (b) Paints, primers, primer surfacers, sealers, enamels and lacquers
    - (c) Masking; tapes, covers, liquid masking compound
    - (d) Demonstration of spray painting

CAUTION - SPRAY PAINTING
Before undertaking spray painting an approved spray booth installation with approved safety features must be provided.

12. Welding

Refer to the Grade 9 Welding course and select suitable topics.

AUTO BODY REPAIR

Grade 10

The course of study in this grade should deal in greater detail with the names, purposes, locations and method of assembly of the major body parts and should provide for simple repair, fitting and adjustment of minor body parts.

SAFETY: Safe practices in the use of tools and equipment should be stressed and the topics listed under safety in Grade 9 reviewed.

1. Cleanliness

   (a) Proper regard for personal and shop cleanliness should be emphasized

   (b) Customer's car - use of seat covers and fender covers, cleaning steering wheel and controls

2. (a) A review of Grade 9 work

   (b) Shop regulations and trade requirements

3. Types of Tools

   (a) A study of the portable power tools used in auto body repair

   (b) Safe operation of air and electric metal cutting equipment, disk and vibrator sanders

4. Welding and Brazing

   (a) Refer to Grade 10 Welding course and select suitable topics on welding and brazing

   (b) Practice in controlling warpage, forging a weld, shrinking metal and welding auto body steel

5. Metal Repairing

   (a) During this year the student should be taught the method of surveying simple metal damage and the sequence of repair

   (b) The procedure for straightening by bumping, picking, filing and checking with the hand

6. Corrosion and Rust Repair

   (a) Cutting out damaged area

   (b) Patching - over top and underneath

   (c) Cleaning the metal, preparation for soldering

7. Soldering

   (a) Types of solders and fluxes

   (b) Methods of tinning

   (c) Methods of applying solder (flat position); solder paddles and their use

   (d) Filing solder

   (e) Finishing by block sanding

8. Preparation for Refinishing

   (a) Removal of waxes and silicones

   (b) Sanding - sand papers and their proper use

   (c) Cleaning the metal

   (d) Masking methods and types of tapes

9. Spraying Equipment

   CAUTION - SPRAY PAINTING

   Before undertaking spray painting an approved spray booth installation with approved safety features must be provided.

   (a) Simple spray gun adjustments - operation of a spray gun

   (b) Spray gun techniques

   (c) Care and cleaning of spray guns

10. Refinishing

   (a) Application of primer surfacer

   (b) Glazing and sanding

   (c) Applying the finish coat

11. Removing, Replacing and Servicing Parts

   (a) Remove and replace headlamp assembly, minor body trim, interior and exterior sun visors, radio antennae, inner door handles, door pads, weatherstrips, door garnish and other types of mouldings

   (b) Disassemble a headlamp unit, identify the parts, replace, adjust and focus

   (c) Types of fastenings used for body trim and escutcheon plates

12. Locks and Controls

   (a) Types of hood latches and trunk lid locks - adjustments

   (b) Glove compartment and gas filler doors

13. Upholstery (Optional)

    (a) Cleaning by vacuum cleaner

    (b) Spot removing with cleaning solvents

    (c) Shampooing

AUTO BODY REPAIR

Grade 11

Automobiles should be used for the practical work in this course.

Since welding and power equipment are to be used, safety and the correct use of the equipment should be stressed at all times.

1. Safety

    (a) A review of the safety topics previously listed

    (b) Cleanliness of shop

    (c) Welding

    (d) Combustible materials

    (e) Automobiles

    (f) Power equipment

    (g) Fibreglass and plastics

2. Review Grades 9 and 10 where necessary as a foundation for Grade 11.

3. Welding and Brazing

    A review and further study of controlling warpage and welding and brazing practices used in auto body repair. The welding of light gauge metals should be practiced.

    Precautions regarding upholstery, wiring, wind cords, plastics and gas tanks should be emphasized.

4. Special Tools and Equipment

    Hand tools, body jacks and attachments, hydraulic and mechanical; proper methods of grinding, types of discs and attachments; air and electric tools for cutting, flanging and sanding

5. Metal Repair

    (a) A study of direct and indirect damage

    (b) Repairing different types of damage: high crown surface bumping, low crown or flat surface bumping, removing damaged area and fitting a repair panel, patch and simple panel making - installation, welding sheet metal panels and sills - problems of expansion and contraction, shrinking metal

(c) Soldering: types of solders and soldering fluxes; tinning: zinc chloride, acid-core and brush-type soldering flux; method of "paddling" solder (flat and vertical); finishing solder - filing and sanding

(d) Plastic repair: types of plastics and fibreglass, proper application, finishing

6. Chassis

Frame construction; types of frames; the difference between the conventional type of frame and the unitized body and frame; types of frame and unit body damage; how the conventional type of frame reacts to damage as compared to the unitized body and frame; chassis parts - suspension front and rear; checking frame damage by simple measurements and by use of a trammel gauge

7. Removal, Replacement and Servicing of Parts

Door handles and locks, window regulators, inside controls, door glass and vent assemblies, seat tracks and controls (not powerized), air ducts and vent controls, bumpers, grilles, radiators, fenders, inner fender pans and stone shields, all types of exterior mouldings

8. Trim

Remove and replace doors, quarter trim and seat covers; repair seats (metal only)

9. Spray Guns

Types and adjustments, pressures, spray patterns, spray techniques, troubles and remedies, cleaning and normal maintenance

CAUTION - SPRAY PAINTING

Before undertaking spray painting an approved spray booth installation with approved safety features must be provided.

10. Preparation for Refinishing

Cleaning bare metal and old paint, wax removal; methods of neutralizing the soldering fluxes; types of sandpaper and their use; methods of sanding; masking tapes and methods of masking

11. Priming the Surface

Types of primers and primer surfacers, thinners and reducers, application of primer or primer surfacer, glazing

12. Painting

Types of paints; thinning, reducing and mixing; preparation for application of colour coats; application of colour coats; compounding and polishing lacquer finishes; methods of removing masking, i.e., two tone

AUTO BODY REPAIR

Grade 12

Attention should be given to the types of body and frame damage and suitable projects selected that require the use of power equipment such as jacks, pullers, air and electric tools.

Complete body refinishing should be studied and when replacing panels, fitting should be stressed.

SAFETY: The safety measures previously outlined should be periodically reviewed.

1. A brief review of Grade 11 work

2. Welding and Brazing

   A study of the welding and brazing techniques in common use in auto body shops for repairing bodies, frames, grilles and aluminum and die-cast parts

3. Special Tools and Equipment

   (a) Extension of Grade 11 studies to include all power tools, equipment and attachments used in auto body repair

   (b) Introduction and practical application of portable pulling equipment and portable frame machine

4. Metal Repair

   (a) A further study of metal repair methods to include all aspects of metal repair in common use

   (b) Detailed study of the effects of heat on metals: heat distortion - causes and correction; use of heat as a correcting factor

   (c) Shrinking: methods of shrinking with and without water

   (d) Aluminum: gauges, types and alloys, annealing, shrinking, metal finishing, tinning and soldering

5. Soldering

   (a) Review soldering Grade 11

   (b) Method of heating

   (c) Expansion control

   (d) Solder paddling - all positions

6. Plastics

   (a) Types - fibreglass and body filler

   (b) Uses

   (c) Proper application on steel and fibreglass

(d) Finishing

7. Chassis - Terms - Discussion only

   (a) Terminology of steering, i.e. caster, camber

   (b) Geometry of steering

   (c) Ackerman's Principle of steering

   (d) Frame alignments - correction of minor damage

8. Fitting and Alignment

   (a) Methods of fitting and alignment by shimming, adjusting, bending, pulling and jacking of: hoods, trunk decks, front fender assembly, door and windows

   (b) Remove, replace and adjust various types of door locks and window mechanisms

   (c) Elimination of water leaks

9. Glass

   (a) Types of glass and markings - care in handling

   (b) Methods of fastening

   (c) Methods of removing and replacing glass

   (d) Demonstration of the removal and replacement of a vent glass and rear window or a windshield

10. Trim

    Types of trim; removing and replacing head lining and steering wheel; repairing head lining (simple repair only), seats and back rests

11. Electrical - Simple Repair and Replacements

    (a) Simple wiring circuit - fundamentals

    (b) Minor repairs to signal lights, parking lights, tail lights and license lamps

12. Spray Equipment

    (a) Spray guns: types and sizes

    (b) Hoses: types, colour, composition, air pressure drop

    (c) Air transformers and regulators

    (d) Compressors: types, minor maintenance and safety devices

    (e) Infra - red dryers - Portable unit

13. Paints

Primers, primer surfacers, sealers, enamels, lacquers, glazing putty

(a) Composition of each

(b) A study of the methods of application of each

(c) Preparation of spray materials

(d) Use and purpose of each

14. Spray Gun Techniques

CAUTION - SPRAY PAINTING

Before undertaking spray painting an approved spray booth installation with approved safety features must be provided.

(a) Stroking

(b) Triggering

(c) Distance from surface

(d) Angles and patterns

15. Paint Application

(a) Spotting in

(b) Painting a panel

(c) Complete refinishing of the automobile

AUTO MECHANICS

Four-Year Programme Grades 9, 10, 11 and 12

Grade 9

SAFETY: Safety precautions in regard to toxic and explosive fumes and gases, lifting equipment, hand and power tools; shop and personal cleanliness should be emphasized.

When feasible suitable units should be dismantled and assembled.

1. Chassis

   (a) Parts: examination and study to obtain the name, purpose and location of principal parts

   (b) Specifications: wheel base, spring suspension, steering-gear ratio, tread and road clearance

2. Names and Purpose of Common Automotive Tools

3. Engines

   (a) Parts: identification of parts, dismantling and assembling piston and valve assemblies

   (b) Principles of the four-stroke cycle; fuel-air mixtures; properties and danger of carbon monoxide gas - precautions

4. Lubrication

   Purpose, simple theory, description and methods of lubricating engine and chassis

5. Cooling System

   Purpose, simple theory and examination of liquid and air cooling systems

6. Electrical System

   Fundamentals of electricity and magnetism, circuits, electro-magnets, insulators, conductors and resistors. Tracing a simple ignition circuit and studying its operation

7. Fuel System and Fuel

   (a) Name and purpose of units

   (b) Gasoline: use, precautions for its use, method of storing, methods of extinguishing fires; gasoline prohibited for cleaning purposes

8. Fastenings

   Identification of bolts, nuts, cap screws, threads, rivets, washers, cotter pins; their use and application

9. Transmission System

   (a) Construction and operation of single-plate clutch

   (b) Transmission: standard positions, speed ratios; mechanical advantages

   (c) Drive shaft, Hotchkiss and torque tube types

   (d) Differential, purpose

   (e) Rear axles, types

10. Running Gear

   (a) Front wheel suspension

   (b) Steering, gear principle

   (c) Brakes, simple theory

AUTO MECHANICS

Grade 10

The course of study in this grade should deal in greater detail with the names, purpose, location, and operation of the principal parts of the modern automobile and should provide for simple fitting and adjustment during assembly and replacement operations. Running engines are required.

Names and purpose of additional automotive tools such as taps, dies, micrometers and reamers.

SAFETY: Safety precautions in regard to toxic and explosive fumes and gases, lifting equipment, hand and power tools; shop and personal cleanliness should be emphasized.

1. Engines

   (a) Piston assembly: relative position of pistons in various cylinders, compression ratios and compression pressures, detailed examination of pistons, rings, connecting rods and bearings

   (b) Crankshaft: relation to stroke, r.p.m.

   (c) Valves: arrangement as to heads, seats, faces, springs, locking, guides, tappets and clearances; timing valves with and without marks; valve lap, lead and lag; relationship of stroke to degrees

   (d) Horsepower: brief reference to horsepower formula as used for license purposes

   (e) Single cylinder engine - two and four stroke cycle

2. Lubrication

   (a) Study of a lubrication system for modern automobile engines and chassis; kinds of lubricants, lubrication charts, S.A.E., viscosity ratings, effect of extreme temperatures, filters

3. Fuel System

   (a) Construction and operation of modern single and multi-throat carburetors; types and purposes

   (b) Dismantling and reassembling carburetor to identify the parts commonly requiring replacement; carburetor reconditioning and reassembling; adjustments; carburetor final adjustments and settings on a running engine

   (c) Brief reference to injector and pump system used on diesel engines

4. Engine Tune-up Operations

   (a) Determining mechanical condition of engine before proceeding with engine tune-up

   (b) Operations in engine tune-up and importance of correct sequence; battery condition, compression test, ignition system, fuel system; final running test using tachometer, vacuum gauge and engine analyser.

   (c) Thermal efficiency, volumetric efficiency, mechanical efficiency and load test by dynamometer

5. Transmission System

   (a) Common clutch troubles; reconditioning modern clutch; replacing clutch facings and bearings; aligning clutch; clutch adjustment

   (b) Construction and operation of popular form of synchronized type transmission; typical service problems and overhauling procedure

   (c) Service requirements of universal joints

   (d) Diagnosing and correcting various rear axle troubles

   (e) Principles of automatic transmissions

   (f) Gear lubricants for particular requirements

6. Running Gear

   (a) Types of front wheel suspension

   (b) Steering gear troubles: causes and remedies; checking front wheel alignment; steering geometry; adjusting steering gear and linkage on independent wheel suspension

   (c) Principles of power steering

   (d) Construction and operation of hydraulic brake system; common troubles of brake system; reconditioning brake cylinders and bleeding brake systems

   (e) Removing, replacing and adjusting a complete set of brakes

   (f) Principles of power brakes

DRAFTING

Four-Year Programme Grades 9 and 10

Grade 9

The drafting course outline for Grades 9 and 10 is general in nature and suitable architectural and mechanical drafting projects should be selected to provide the pupil with experience in architectural and mechanical drafting.

Note: All work to be done according to C.S.A. Standards.

1. Development of Drafting Skills

   (a) The use and care of the elementary drafting instruments

   (b) The development of skill in single stroke freehand capital lettering; the alphabet, figures and fractions; application in notes and dimensions

   (c) Recognition, through use, of the alphabet of lines; visible outline, hidden line, centre line, dimension line, extension line, leader line, section line, cutting plane line and break line

   (d) Technique in measuring, using the full-size scale

   (e) One-view drawings such as templates, gates, street and plot plan to develop the skills required in using the instruments

2. Orthographic Projection (2 view to 6 view)

   Freehand sketching of orthographic views from pictorial representations and objects to illustrate the correct placement of views and the difference between orthographic views and pictorial drawings

3. Working Drawings

   (a) Two- and three-view working drawings, from both pictorial drawings and models, to scale, such as full, half size or 3" = 1 foot, of rectangular objects, angular objects which require straight lines only such as wedges and tapers, objects with curved surfaces involving circles and parts of circles

   (b) Spacing of views for proper balance

   (c) Elementary dimensioning, including the locating and dimensioning of circles, arcs and angles

   (d) Full sections and half sections; methods of indicating the section and the materials by cross-hatching (common materials only)

   (e) Geometric constructions to be included in the classroom drafting project as required

4. (a) Detail drawings of simple parts to illustrate conventional indications for operations such as drilling, threading and tapping; finish marks. In introducing threading the simplified symbol should be stressed.

   (b) Drawing of simple assemblies of two or more parts to show the relationship of the parts, the method of dimensioning the assembly and to introduce the bill of material and parts list

5. Blueprint Reading

   Examining simple drawings and blueprints of shop projects and other objects to learn the sizes, shapes, details, materials and processes as specified

Grade 10

In this course suitable architectural, mechanical and electrical drafting projects should be selected which provide the pupil with some experience in these fields.

Note: All work to be done according to C.S.A. Standards.

1. Orthographic Projection

   Problems to illustrate the principles of third angle projection: objects with surfaces not parallel to one another; obliquely-cut objects such as frustums of pyramids and cones; incomplete views and auxiliary views

2. Pictorial Drawing

   The use of pictorial drawings expressed in such forms as isometric, cabinet and oblique; introduction of pictorial drawing practice including dimensioning

3. Section Views

   Offset, removed, revolved, broken-out and phantom sections, assembly in section

4. Geometric Construction

   Drafting problems involving such layouts as the hexagon, octagon and pentagon; the division of circles and lines and the bisection of angles and lines. This work should be included in classroom drafting projects.

5. Intersection of Surfaces

   Plotting the lines of intersections of cylindrical and rectangular shapes joining at various angles such as on machine parts

6. Development of Surfaces

   Developing patterns for rectangular objects; parallel line development of patterns for right and oblique cut cylinders; two piece elbows and scoops; radial line development applied to conical and pyramidal shapes; extension of parallel line development to three and four-piece elbows. Developments involving a combination of both methods for pattern layout may be made from paper or in the sheet metal shop if available

7. Working Drawings of a More Advanced Nature

Drawings of a more difficult nature involving the placement, number and dimensioning of views; sections; simplified and regular symbols for threads; notation; National, Unified, Acme and Square threads in sufficient detail to adequately specify and represent them on detail and assembly drawings; bill of material and assembly drawings. The drawings should be selected from shop projects when suitable. The making of sketch plans before starting the scale drawings should be encouraged.

8. Blueprint Reading

For machine trades; building construction and electrical trades; reading drawings representative of the technical work taught in the school and the work done in local industries

9. Optional Topics

(a) Map or topographical drawing: drawing a land plot from field sketch and notes; indications for topographical features

(b) Tracing and reproduction of drawings: the student who makes rapid progress in drafting may be given some inking or pencil drawing on tracing paper

ARCHITECTURAL DRAFTING

Four-Year Programme Grades 11 and 12

Grade 11

1. Building Construction Details

(a) Preparation of working details involving the following elements singly or in combination

Foundations: soil conditions; slab, stepped, offset, plain and reinforced footings; post, pier, column and wall foundations; foundation waterproofing

Frame wall construction: elements of balloon, platform or western and braced frames; wood coverings

Masonry wall construction: wall thickness; face and backing units

Wood floor construction: joist arrangement, fire-stops, bridging, girders, trimming, floors

Carpentry and joinery: joints, rough and finished carpentry, trim details

Windows: double-hung, casements in wood and metal; mullions, caulking; types for wood and masonry walls

Doors: construction, exterior and interior types and sizes, hardware

Fireplaces: hearth, throat and flue construction, surround and mantel

Chimneys: flue types and sizes; wall sizes and materials; cleanouts

Stairs: types; open-and closed-string construction, tread, riser and hand-rail relation

Wood roof framing: wood truss construction; elements of the flat, lean-to, hip, gable, gambrel, mansard types; dormers, coverings, cornices

Flashings: for hips, valleys, chimneys, cornices, parapets, soil pipes

(b) Layouts and working drawings: incorporation of the foregoing details in the working drawings for a kitchen equipment layout, summer cottage or similar project

(c) Some brief exercises in inking and an introduction to the use of lettering devices may be given

2. Building Materials and Methods

An elementary study of the materials of building construction and the local building by-laws and practices. This study should be carried on concurrently with the preparation of the details outlined in 1 above.

(a) Wood: drying, shrinkage, defects, sawing, grading, measurement; properties and uses of various building woods

(b) Lime: properties; crushed and hydrated; mortar, plaster

(c) Portland cement: properties, uses in mortar, stucco, concrete

(d) Brick: varieties, uses, types of bonds, joints, mortar

(e) Stone: classifications, properties and uses of granite, limestone, sandstone, marble, slate and shale; properties and application of rubble, ashlar, veneers; bonding and waterproofing

(f) Concrete: proportions, mixing, placing, curing, forms, uses of steel reinforcing, pre-stressing

(g) Gypsum products: properties of gypsum; uses in plasters, boards, blocks, slabs; dry wall construction

(h) Masonry units: concrete, cinder-concrete, silica, clay blocks

(i) Flooring: wood, concrete, terrazzo, mastic, tile, linoleum, cork and rubber coverings

(j) Glass: varieties, commercial standards; structural glass and block

(k) Paints: composition and uses of paints, enamels, varnishes and stains; paints for wood, metal, plaster, concrete

(l) Metals: properties and uses of iron, steel, copper, lead, zinc, tin

(m) Insulation: types, application, vapour barrier

3. Structural Design

The objectives of this course are to teach good engineering procedures and to familiarize the student with present day structural design methods.

(a) Strength of materials: definition; use in structural design

(b) Forces: compression, tension, shear, elements of a force, vectors

(c) Stresses: mechanical properties of materials, strength, stiffness, elasticity, ductility, malleability, deformation, elastic limit, yield point and ultimate strength, modulus of elasticity, factor of safety, allowable unit stresses

(d) Equilibrium: definition, parallelogram of forces, resultants, equilibrant

(e) Beam design:

Types of loads: point load and uniformly distributed load; conditions for equilibrium; principle of moments

Reactions: calculation of R1 and R2, simple beams, cantilever beams

Vertical shear, calculations - diagram

Bending moment, calculations - diagram

Internal resistance - resisting moment, horizontal shear (for timber only)

Flexure formulae. Determination of section modulus. Selection of beam - timber, steel

Deflection: definition, maximum deflection for a beam with a concentrated or point load at the centre; maximum deflection for a beam with a uniformly distributed load. Formulae for beam deflection

Simple problems in beam design in steel and timber

4. Structural Steel Drafting (To be continued through Grade 12)

   (a) Drafting: drafting room organization, personnel, procedures

   (b) Conventions and symbols:

      Plain material; structural steel

      Method of billing and sketching structural steel shapes on shop drawings

      Conventions and symbols for structural shapes

      Dimensions and weights of various structural steel sections

   (c) Use of hand-books and other reference materials: American Institute of Steel Construction Manual

   (d) Design drawings: graphical analysis, framing plans and details, column schedules

   (e) Shop detail drawings: beams, lintels, columns, trusses, long span steel joists, bills of material, layouts

   (f) Fabrication: material handling and cutting, use of templets, layout, punching and drilling, bending and bulldozing, fitting up, reaming, riveting, high tensile bolts, welding, painting and marking, inspection

   (g) Erection: transportation, equipment, erection on the site, placing, aligning, fastening, bolting and riveting, field painting

5. Perspective and Rendering

   (a) General principles of perspective projection; determination of station point, picture plane, horizon, lines of heights and vanishing points

   (b) Problems in angular and parallel perspective applied to angular and pyramidal solids, curved lines and cylinders

   (c) Rendering in pencil of simple forms in light and shade; rendering of simple architectural instrumental perspective in pencil

6. Estimating (To be continued through Grade 12)

   (a) Approximate methods of estimating building construction by the cubic foot and square foot

(b) Consideration of the units of measurement, methods of estimating and pricing for general items, excavation, grading, brick work, mortar, rough and dressed stonework, concrete, concrete block, waterproofing, rough wood framing, sheathing, siding, shingles, frames and sash, exterior and interior doors, finish carpentry, trim, fittings, wood flooring, linoleum, sheet metal work, built-up roofing, lathing, plastering, painting, glazing, floor and wall tile work, electric wiring, heating, plumbing and insulation

(c) Application of (b) above in "taking off" quantities from blueprints. Use the actual blueprints of a small residence or industrial building.

7. Scale Models (Optional)

Presentation models of projects in various media

8. History of Architecture and Design

(a) General outline of the history of ancient building with emphasis on the Greek and Roman periods, particular attention being given to the use of materials, methods of construction and to the form and proportion of details of these periods which are still in use

(b) Freehand sketches or formal drawings of representative details of the various periods

Grade 12

1. Working Drawings

(a) Residence plans: preparation of working drawings of a small residence at a scale of ¼" = 1' - 0", complete with details such as wall sections, windows, main entrance doorway, porches, cornice, bay windows, dormers, kitchen cupboards, staircase, mantel and interior trim

(b) Some exercise in inking

(c) Mechanical equipment layouts: piping diagrams for hot-water heating and water-supply systems; duct layout for the heating and ventilating of a small building

(d) Structural steel details: working details using standard shapes for steel-framed floor bay or similiar project

(e) Surveys: drawing of a land plot from notes prepared in the field, showing buildings, natural features, levels, linear and angular measurements; measurement of building details

2. Building Materials and Methods

The work of Grade 11 extended to include the following topics

(a) Running lines and staking out

(b) Organization of work and sequence of trades

MECHANICAL DRAFTING

Four-Year Programme Grades 11 and 12

Grade 11

Note: All work to be done according to C.S.A. Standards.

1. Detail and Assembly Drawing

   (a) Machine fastenings: selection of and correct specifications for machine screws, studs, bolts, nuts, washers, taper pins, cotter pins, retaining rings and other fasteners

   (b) Keys and key-seats

   (c) Threads: National and Unified; coarse, fine and extra fine threads, multiple threads, Acme, Square and Whitworth threads, right and left hand threads; pipe threads
   Familiarization with terms: pitch, depth of thread, major diameter and minor diameter

   (d) Machine fits, tolerance, C.S.A. standards

   (e) Sections: revolved, removed, broken-out and phantom; assembly in section

   (f) Drawing of machine parts from notes and sketches obtained by measuring actual objects

   (g) Selection and use of common metals and materials

   (h) Specifying and listing detailed and stock parts on the drawing and in the bill of material

   (i) Pencil drawing on transparent paper, inking and reproduction. Inking should be touched on only briefly.

   (j) Use of lettering devices

   (k) Dimensioning - Introduction to and use of complete decimal and metric systems of dimensioning

2. Surface Finish

   Machining operations to include surface quality for appearance and application. C.S.A. symbols for surface roughness, waviness and lay

3. Casting Design

   Elementary casting design and foundry practice

4. Geometric Construction

   Geometric layout for an ellipse and helical, tangential, involute and cycloidal curves

5. Cams and Linkages

   (a) Development of cams to produce uniform motion, harmonic motion, variable motion and quick return motion

(b) Application of levers, cranks, linkages and cams to obtain various motions and movements in mechanical devices

6. Gearing

The greater part of the time for this topic should be spent on fundamentals of gearing, uses of various gears and formulae

(a) Spur gears: tooth parts; plotting tooth curves by the base circle method; drafting problems involving details of pinions and spur gears; working drawings of spur gears using the conventional symbols and data block instead of detailing tooth shapes

(b) Bevel gears, right angle only

7. Jigs and Fixtures

A study of the layout of jigs and fixtures for performing machine operations; design and draw a simple jig such as a drill jig; application of shop mathematics in determining angles, offsets and in dimensioning

8. Pictorial Drawing

The continuation of pictorial drawing as taught in Grade 10. Emphasis to be placed on pictorial sketching. Perspective drawing and sketching may be included if time permits

9. Auxiliary Views

Continuation of auxiliary views as taught in Grade 10. Introduction of secondary auxiliary views and revolutions

10. Drawing of Fabricated Parts

Standard structural shapes, fabrication practices and welding symbols

11. Forging

Design and drawing practices

12. Optional Topics

(a) Standard structural shapes - introduction to the structural steel handbook; simple structural steel detail drawings, rivet symbols, pitch of rivets, dimensioning, gusset plates and base plates

(b) Lap and butt joints, types of rivets, bolts and welds

(c) Bill of material, calculation of lengths for rivets and bolts; preparation of rivet and bolt lists for shop and field work; paints and surface protection for structural steel

(d) A study of the methods of constructing gear trains (spur, bevel, rack and pinion); speed-changing problems; calculation of the horsepower transmitted by spur and bevel gears using the Lewis formula

(e) Architectural Drafting: problems may be taken from the Architectural Drafting course of study for Grade 11

(f) Electrical Drafting: problems may be taken from the Eletrical Drafting course of study for Grade 11

Grade 12

Note: All work to be done according to C.S.A. Standards.

1. Machine Drawing and Design
    - (a) Gathering data from catalogues, hand-books and reference books
    - (b) Calculations of speed and feeds and sizes of gears and pulleys
    - (c) Shafts and couplings: flange couplings, shaft collars, fluted and splined shafts, universal joints, flexible couplings
    - (d) Bearings: friction and anti-friction, methods of lubrication; use of manufacturer's hand-books
    - (e) Sketching and dimensioning machined parts
    - (f) Discussion of pattern making problems and moulding practice
    - (g) Checking detail and assembly drawings for accuracy, dimensioning, proper drawing practice, design and function
    - (h) Preparing weight sheets, cost sheets and material shop orders
    - (i) Selection of materials: S.A.E., and A.I.S.I. steels, various metals, plastics and other materials
    - (j) Assembly and detail drawings; specifying and listing of detailed and stock parts on the drawing and in the bill of material
    - (k) Drawing on transparent paper, sepia intermediate paper and plastic film
2. Gears, Cams, Linkages and Actuators
    - (a) Use of formulae and prepared tables of gear data for advanced problems in spur and bevel gears, worm gears, racks and pinions
    - (b) Drafting problems in the layout of devices producing mechanical movements by means of linkages, cams and electrical, hydraulic and pneumatic actuators
    - (c) Transmission problems involving gears, shafts and bearings, such as in a geared winch or other geared drives or mechanisms
3. Dies and Die Design
    - (a) Types of dies, blanking, punching, bending and any other type used in the local area
    - (b) Parts of a die set: die shoe, die, stripper and guide plate, guide pins, dowel pins, punch, punch holder, shank, guide-pin bushings and stops
      Die set materials
    - (c) Layouts and drawings for a punching and blanking die set complete with specifications for materials

4. Sheet Metal Pattern Drafting

Problems combining several methods of development of surfaces; triangulation and radial line methods applied to such projects as the layout of ventilators, transition pieces, tapered funnel-top, measuring can, cornice and cornice mitres, sheet metal caps and finials; the development of the sphere and hemisphere using the gore and zone methods

5. Strength of Materials

Machine design and structural problems involving elements of strength of materials; simple tension, compression, torsion, bearing, direct shear and bending or deflection; unit stress, unit strain, ultimate stress, elastic limit, safe working stress, factors of safety; use of hand-books to determine physical properties of materials

6. Weights of Materials

Calculation of weights of castings, materials, structural steel, stock and machined parts

7. New Materials, Processes and Techniques

Pupils should be made familiar with any new processes or techniques as they become accepted; such information might concern powder metallurgy, high temperature resistant alloys, materials with a low coefficient of friction, electric discharge machining, explosive metal forming, new metals, plastics and other materials

8. Drafting Office Routine

Drafting office organization, filing and routing systems, division of staff duties and responsibilities

9. Optional Topics

(a) Structural steel drawing: graphical solutions for stress diagrams of simple frames such as derrick frames and Pratt and Fink trusses; design of a simple Fink truss complete with calculations for the members; use of the structural steel hand-books; the selection of standard shapes; efficiency of riveted joints; application of mathematics for calculating bevels and for accurate layout; bill of material and weight sheets; use of letter indications and match marks for assembly; erection diagrams

(b) Piping: single line, double line and isometric; piping symbols

(c) Architectural Drafting: problems may be taken from the Architectural Drafting course of study, Grades 11 and 12

(d) Electrical Drafting: problems may be taken from the Electrical Drafting course of study, Grades 11 and 12

(e) Intersection of surfaces: plotting the lines of intersection of objects of various shapes joining at various angles

GRAPHIC ARTS

Four-Year Programme Grades 9, 10, 11 and 12

Grade 9

Type Composition (Hand)

1. The California Job Case and Contents

   Character and purpose of the case; the lower case letters, plan and reason for arrangement; the capitals, numerals, punctuation marks, ligatures, spaces and quads

2. The Composing Stick

   Kinds, parts and adjustment; use, care, posture for setting; pulling a proof in the stick; distribution from the stick; justification; simple flush lines

3. Type

   Composition, parts, functions, fontage; characteristics of similar letters, how identified, type and print compared; point system of measuring; point system as applied to leads, slugs and other material

4. Hand Composition

   Spacing, justifying, centering, quadding; indention and justification as applied to regular paragraph work; poetry, flush, indented, turnovers, quotations

5. Proofreading

   Correction of work with elementary introduction to the use of the principal marks and their meanings

6. Safety precautions applicable to equipment
7. Technical and Trade Terms
8. Careers in Printing

Letterpress Presswork

The Platen Press

Development of the platen press, parts, care and oiling, inking, hand feeding, cleaning form, washing-up, packing platen, regulating impression, printers' system of measurement, setting gauge pins, gripper and adjustment, lock-up, safety precautions, technical and trade terms

Grade 10

Type Composition (Hand)

SAFETY: Shop rules, safety precautions and safe practices in the use of tools and equipment and in the handling of chemicals should be stressed.

1. History of Printing (Gutenberg to Bodoni)

2. Review of Type Composition, Grade 9

3. Elementary Composition

   Dumping and tying - methods, precautions and development of skill; pulling proofs on the galley - advantages, procedure and standard of cleanliness necessary; distributing from the galley; correcting in the stick and on the galley - general classification of corrections and proper procedure, special corrections including overrunning; punctuation marks and spacing - standard practice for the spacing of the period, comma, hyphen, colon, semicolon, exclamation mark, question mark, apostrophe, dash, parentheses and brackets

4. The Point System

   The point system of sizes and measurements; point system as applied to leads, slugs and other materials

5. Proofreading

   Symbols, use of symbols in the study of a proofread model; assigned proofreading

6. Special Composition

   (a) Numbering sentences and paragraphs: alternate use of numbers and letters

   (b) Setting indentions: review of regular paragraph indention and extension of study to include hanging, half-diamond, squared and diagonal

   (c) Setting numbers: three ways of expressing numbers; rules for comma, usage and examples of correct usage

   (d) Tabular composition: rules for procedure in setting up a simple example of tabulated form

   (e) Multiple justification: advantages and procedure

   (f) Leading

   (g) Initial letters: history, purpose, extent of use, rules for use in composition

   (h) Leaders and rules: examples, purpose, procedure for composition

   (i) Borders: purposes, common types, margins, procedure for making butted rule border and mitred border

7. Composing Room Equipment

   Hand mitering machine, lead and slug cutter, imposing stone, furniture and racks

8. Single Page Lockup

   Materials, uses, positions and procedure

9. Newspaper and Job Work Display

   Headings, subheadings, running heads and display lines

10. Technical and Trade Terms

Letterpress Presswork

1. Review of Grade 9 Presswork

2. Hand-Fed Platens

   Putting job on the press; reading work docket, preparing press, putting form on, precautions, positioning, elementary make-ready, checking and proofreading, final approval

Offset Printing—Plate Preparation

1. Cleanliness and care in handling

2. Types of Plates Available

   Light sensitive, paper and metal; direct image, paper and metal

3. Copy Preparation

   Repro proofs, typewritten, individual letters, reprints, paste-ups, art work

4. Auto-positive Film

   Handling of light-sensitive materials, developing and fixing, time and temperature factors

5. Mounting and Stripping

   Tools and equipment. positioning, windows, opaquing

6. Exposing the Plate

   Methods of exposure, time and light factors; developing chemicals and their proper use

7. Technical and Trade Terms

Offset Printing—Presswork

1. Outline of the development of the Offset Process. Advantages over direct lithography; 2 and 3 cylinder principles

2. Care of the Press

   Lubrication and cleanliness; washup

3. Press Chemicals

   Plate etch, fountain etch, plate gum, blanket wash, water, ink

4. Press Control and Adjustments

   Inking system, dampening system, feeder mechanism controls and operation, delivery adjustments

5. Operating Adjustments

   Balance of water and ink, handling of inks and chemicals, cylinder pressures

6. Types of Plates

   Suitable chemicals and treatment on the press, proper storage and care of plates

7. Technical and Trade Terms

Grade 11

Type Composition (Hand)

SAFETY: Emphasis should be placed on the development of safe practices in the handling and use of tools, equipment, solvents and chemicals.

1. Review of Type Composition, Grade 10

2. History of Printing (Caxton to Mergenthaler)

3. Study of Materials

   (a) Type faces: classification into basic groups—Roman, Italic, Text, Sans Serif or Gothic, Script or Cursive, Square Serif, Novelty; a comparative study of available faces in the shop, identifying characteristics; Roman subdivided into old-style, modern, transitional

   (b) Recognition of type faces, type specimen book

   (c) Type sizes: application of point system, fontage, alignment, shoulder depth

   (d) Type series

   (e) Type families: development from original face—italic, bolder, lighter, condensed, extended; unity with variety

Letterpress Presswork

1. Review of Grade 11 Presswork

2. Shop Standards

   Safety, cleanliness and quality control

3. Cylinder Presses

   History of cylinder presses; types: stop cylinder, two revolution, flat bed and vertical
   Packing: hard and soft, precautions, results of over and under packing, hangers, depth of make-ready sheet
   Controls: names and parts, functions of press controls, adjustments
   Setting rollers: lateral and vertical setting, stripe and type high block
   Positioning form: avoiding spring, planing to bed, deadline, precautions
   Make-ready: reasons for make-ready, stopping, stabbing, mark-out, patch-up, hanging, spot-up
   Cause of wrinkles and slurs

4. Automatic Presses

   Suitability for various jobs; lubrication, manufacturer's specifications; a thorough understanding of the controls, adjustments and minor servicing of the equipment in the school shop; make-ready as applied to specific presses

5. Paper

   History, manufacturing processes, finishes and suitability for various types of work; stock handling and storage, humidity and temperature problems and control; purchasing stock, estimating costs, spoilage allowance, grain way

6. Ink

   Composition of inks, matching colours, tints, additives for inks; suitability of inks and driers for various papers; newer types of fast-drying inks

7. Special Make-ready

   Scoring, creasing and die cutting; perforating, embossing

8. Process Colour Work

9. Anti Set-Off Equipment

   Sprays, wet and dry; heat

10. Thermography and Metallic Dusting

11. Technical and Trade Terms

Offset Printing—Plate Preparation

1. Review of Grade 11 Plate Preparation. Safety Precautions

2. Graining of Plates

   Different metals, methods, reason

3. Plate Coatings

   Chemicals used and methods of applying

4. Storage of Prepared Plates (Sensitized)

   Time and atmospheric conditions

5. Making of Book Flats and Imposition of Multiple Forms

   Margins and gutters; type of folding equipment and limitations; work and turn, work and tumble, sheetwise

6. Scribing Ruled Forms

   Tools and methods

7. Line-Up Tables

   Types, advantages, ruling, positioning multiple copies or negatives; proper care and use of line-up equipment

8. Making of Combination Flats

   Line and halftone elements; masking for two colour work, one negative; overprints and surprints; plates requiring two flats, reasons and positioning, register marks

9. Halftone Photography

   Types of screens: contact, grey and magenta; glass screens and auto-screen film Exposure computor: calibrating, measuring values of copy, estimating main and flash exposures; use of step guide; two exposure method; three exposure method Filters to increase and decrease contrasts; handling of screens, extreme care necessary; setting up flash lamp; how halftone dots are formed

10. Halftone Developing

    Necessary time, agitation and temperature controls; visual inspection

11. Process Colour Work (Theory)

    Filters, suitable film, copy, transparencies; register marks; dot etching, colour correction and masking

12. Technical and Trade Terms

Offset Printing--Presswork

1. Safety Precautions

2. Review of Grade 11 Presswork - relating learning to larger equipment

3. Types of Offset Presses

4. Setting Cylinder Pressures and Timing of Various Press Parts

5. Servicing Air System on the Press

   Cleaning filters and pumps; cleaning air lines; air line adjustments

6. Types of Plates

   Manufacture and preparation; advantages and disadvantages of each type

7. Inks

   Ingredients, their function and properties

8. Paper

   Ingredients, their purpose and properties; estimating and costing, trade practices

9. Pressroom Problems

   Humidity and temperature control; register (paper distortion, packing of plate and blanket); scumming, tinting, ink, plate image, print, sticking, streaking troubles

10. Chemistry of Presswork

    Chemical ingredients and their purpose

11. Auxiliary Press Equipment

12. Colour Work

    Sequence and problems

13. Careers in Offset Printing

14. Technical and Trade Terms

Binder Work

1. Machines

   Paper cutter, stitcher, perforator, paper drill, folder, collator, padding press. Safety precautions

2. Bindery Operations

   Jogging, cutting, trimming, folding, drilling, perforating, stitching, padding, ruling, gathering, collating, binding, looseleaf binding, mechanical binding, varnishing, bronzing, pebbling, stippling, embossing, wrapping, packing, labelling and mailing

   It is not expected that many of these operations will be performed in a school Printing Department. However, the student should be taught the work of a Bindery so that he may know what happens to the work after it leaves the Press Room. A tour of a book publishing company would enable the students to see many of these operations.

INDUSTRIAL CHEMISTRY

Four-Year Programme Grades 11 and 12

Grade 11

The aim of the course is to produce chemical technicians who have a grounding in basic chemical theory and who also have considerable training in technique.

The course in Industrial Chemistry may vary somewhat from school to school and be influenced by the needs of local industry.

1. General Chemistry

Note 1 When pupils plan to write the Departmental Examination in Grade 13 Chemistry at the end of the Grade 12 Industrial Chemistry Course, the teacher should ensure that all the topics listed in the Grade 13 Course of Study are covered. In Grade 11 many experiments should be done by the students to establish a firm understanding of equivalent weights, gas laws, vapour pressure.

Note 2 This course should include weekly reading assignments and practice in solving chemical problems.

(a) The atom: structure, size, weight, representation, quantum energy levels

(b) Why atoms unite: valence, covalence

(c) Periodicity: atomic tables

(d) Activity: development of activity list from experiments

(e) Ionization: conductivity experiments, coloured ions, ionic equations

(f) Reactions and equations: review of equations, practice in writing equations; hydrolysis with experiments; electrolysis with experiments, Downs cell, Gibb cell, Hall cell; experiments on equivalent weight

(g) Metals: iron, cobalt, transition elements, principal properties of metals

(h) Oxidation - reduction: examples, electron transfer; balancing redox equations

(i) Equilibrium: reversibility; law of mass action with experiments; dynamic equilibrium; Le Chatelier's principle; Haber process

(j) Ionic equilibrium: acid-base theory; common-ion effect; solubility product and ionization constant

(k) Co-ordination: complex ions

(l) Periodic table: alkali group; copper, silver and gold group; magnesium, calcium, strontium and barium group; zinc, cadmium and mercury group (use in cells and electrodes); aluminum, amphoterism; carbon, silicon, tin, lead; transition elements; alloys; compounds of inorganic carbon, industrial fuels (e.g. coke, water gas and coal gas); nitrogen and phosphorus, allotropes; arsenic, antimony, bismuth, transition from non-metallic to metallic properties; oxygen and sulphur, properties of oxygen, sulphuric acid, hydrogen sulphide, thio-acids; halogens, preparation and gradations of properties within groups and periods

2. Qualitative Analysis

Qualitative analysis provides a good review of chemical principles and an opportunity to work out equations. This topic embraces a study of the application of mass action, ionization, solubility product, co-precipitation, common-ion effect, buffers and pH control

Note: Semi-micro methods may be used to save time and chemicals and to encourage closer observations.

3. Quantitative Analysis (Gravimetric)

(a) Construction, care and use of balances: precision; sensitivity; rest point

(b) Determination of: water of crystallization in a hydrated salt; barium in barium chloride; chlorine in barium chloride; iron in ferrous ammonium sulphate; nickel in steel; silver and copper in a silver coin; lead and tin in solder

Optional: additional analysis of materials of local interest, e.g., coal, steel, limestone, petroleum products

4. Glass Blowing

Nature of the torch flame; grades of laboratory glass; making test tubes; fire-polishing and flame annealing; bending and joining of tubing; making T tubes and Y tubes; making a wash-bottle; lipping; bottoming; making a thistle tube (optional)

5. Mineralogy

Limited to a study of raw material sources for industry

(a) Classification

(b) Physical properties: colour, lustre, streak, hardness, density

(c) Crystals: systems, simple forms, lattice

(d) Identification from a simple chart or tables

(e) Blow-pipe and dry reactions as a review of chemistry

(f) Ore deposits, mining terms, prospecting

(g) Economic uses: abrasives, gems, refractories, pigments, decorative materials, ceramics, radio-active materials, etc.

Grade 12

1. General Chemistry

Continuation and completion of Grade 13 Chemistry

2. Volumetric Analysis

Comparison with gravimetric analysis in regard to accuracy, speed and basis of calculations (mole, molar; equivalent, normal)

(a) Accuracy of pipettes and burettes

(b) Making normal solutions: e.g., hydrochloric acid, sodium hydroxide; primary and secondary standards

(c) Review of pH: theory of indicators, end points, mixed indicators; titration curves (optional)

(d) Determining the percentage of: acetic acid in vinegar; oxalic acid in a cleaner; sodium hydroxide and sodium carbonate in commercial caustic, soda ash, borax and boric acid

(e) Determination of the hardness of water

(f) Estimation of nitrogen in fertilizer, blood, flour

(g) Preparation of a standard permanganate solution and standardization against ferrous salt and sodium oxalate

(h) The principles of reduction using stannous chloride, Jones reductor and hydrogen

(i) Determination of the iron in iron ore

(j) Use of standard cerium and titanium solutions

(k) Determination of the calcium in calcium carbonate and iron in a ferric salt

(l) Preparation of a standard dichromate solution and the use of an inside indicator

(m) Preparation of a standard iodine solution and a standard thiosulphate solution

(n) Determination of: chlorine in bleach; sulphur dioxide in a sulphite; copper by iodine titration

(o) Analysis of unsaturated oils, iodine number

(p) Preparation of a standard solution of silver nitrate; potassium thiocyanate and absorption indicators and their application by Fajans, Mohr and Volhard methods

(q) Gas analysis by absorption. Discussion of weighing devices and of the continuous flow control meters

3. Geology and Fire Assaying

(a) Theory: (i) rock classification; (ii) rock structures; (iii) geological eras and periods with references to local rock formations and industries; (iv) taking of samples for ore analysis; (v) preparation of samples— crushing, grinding, jigging, Wilfley table, sluicing, froth flotation

(b) Experiments: laboratory practice based on section 3 (a) (v); crucible assay of gold and silver ores; scorification of matte and speiss; cupellation; parting of gold-silver beads - use of assay balance; extraction by cyanidation

4. Instrumental Analysis

A study of the principles involved and the applications in process control of the following instruments: saccharimeter or refractometer, pH meter, automatic titrator, Nessler tubes and colorimeter, photoelectrometer, fluorimeter, nephelometer, polarimeter, spectrophotometer, Parr bomb calorimeter, viscometers of various types

5. Photography

This study is to enable the technician to preserve records of laboratory set-ups and make micro-photographs and illustrations of processes and machinery.

Mixing developer and fixer; developing the negative; printing by contact; camera values; film speeds; exposure meters; grades of paper; copying and enlarging; mounting; lenses, light, depth of field, filters, light and shadow effects; slide making; intensifying, reducing, dodging and special effects

6. Organic Chemistry

(a) The vast number of organic compounds and their importance

(b) Nomenclature

(c) The carbon tetrad or tetrahedron; covalent carbon

(d) Determination of percentage composition of carbon compounds

(e) Graphic and structural formulae; isomers, homologues

(f) The petroleum industry and its products: alkanes, alkenes, alkynes, bottled gases, polymers; the cracking process, extraction of products

(g) Alcohols: production and industrial uses

(h) Aldehydes as oxidation derivatives

(i) Ketones

(j) Acids: final product of oxidation; fatty acids; unsaturated acids

(k) Esters: soap, paint, perfume

(l) Comparison of syndets and soaps; soap manufacture, glycerol and its uses

(m) Alkyl halides: ethyl bromide, methylene iodide, chloroform

(n) Ethers: dimethyl, diethyl, dioxane, ethylene oxide and cellosolve

(o) Acid chlorides as reagents

(p) Acid anhydride and chloral

(q) Hydroxy acids: glycolic, malic, lactic, citric

(r) Dicarboxylic acids: oxalic, tartaric, succinic

(s) Amides: acetamide, urea, thiocarbamide, plastics

(t) Amines: reducing agents, deoxidants, ethanolamine, triethanolamines

(u) Cyanogen derivatives

INDUSTRIAL PHYSICS

Four-Year Programme Grades 11 and 12

Grade 11

As a result of the technological advances of recent years there is a demand for employees who have a much broader understanding of the physical sciences.

The aim of this course is to produce industrial technicians capable of filling a wide variety of positions in industry where a basic knowledge of physics is required.

This course would provide an excellent preparation for further study leading to the Grade 2 and Grade 3 Engineering Technician Ratings of the Association of Professional Engineers of Ontario.

The industries in the area will determine to some extent the depth of treatment of the topics outlined.

Students should be given ample opportunity to perform experiments and use equipment.

Note: Weekly problems should be assigned on the topics studied to provide experience in their solution and to clarify and drill the principles involved.

1. Accurate Measurements

Review of the British and Metric units for length, volume and mass; introduction of the M.K.S. system of units; the conversion from one system to another; practice in the use of vernier calipers and micrometers, both metric and British; how to deal with approximate numbers and significant figures

2. Motion and Forces

Forces, inertia and Newton's First Law of Motion; meaning of vector and scalar quantities; speed and velocity; concept of motion; uniform, variable and average velocities; uniform, average and variable acceleration; graphical representations of motion, displacement and acceleration; resolution and composition of vector quantities to find resultants; experimental determination of acceleration due to gravity; derivation of various formulae

Mass and weight; gravitational and absolute units of measurement; Newton's Second Law of Motion with experimental illustrations; momentum and impulse; Newton's Third Law of Motion; the Law of Universal Gravitation

The Law of Conservation of Momentum, its application; centripetal and centrifugal forces; angular motion with applications

3. Energy, Work, Power and Friction

(a) Energy and Work: the meaning and relationship between energy, (P.E. and K.E.), work and power; efficiency; C.G.S., M.K.S. and F.P.S. gravitational and absolute units for measurement; derivation of the formulae P.E. = mgh and K.E. = $\frac{1}{2}mv^2$

Experiments involving the inclined plane and the mechanical equivalent of heat

MACHINE SHOP PRACTICE

Four-Year Programme Grades 9, 10, 11 and 12

Grade 9

This course covers the theory and operation of standard machine tools, bench work, layout, measurement, testing, inspection and metallurgy

SAFETY: The importance of good safety habits must be recognized by all pupils. The safety precautions that a good workman observes to ensure his personal safety and the well-being of others should be stressed

1. Hand Tools and Bench Work

   Trade description and proper use of the following: soft and hard-faced hammers, chisels, punches, files, hand hacksaws, taps and dies, vises, standard wrenches, screw drivers, letter and number stamps and abrasive cloth

2. Layout Work

   Preparation of metal surfaces for layout with copper sulphate, chalk and layout dye. To layout work from blueprints or drawings using the steel rule, combination set, divider, scriber, hermaphrodite caliper, surface gauge, layout punch and centre punch

3. Measurement

   The care and use of the steel rule, calipers, outside micrometers and graduated collars

4. Machine Tools

   (a) Lathe: types and sizes; the care and lubrication of lathes; identification of the headstock, tailstock, drive plate, centres, bed, carriage and operating controls. To set up for and perform the following operations: parallel turning, facing, turning to a shoulder, grooving, turning a taper using the tailstock offset method, taper turning using the compound rest, knurling, filing and polishing. The construction features and application of 3 and 4 jaw chucks and practice in their use

   (b) Horizontal Milling Machine: types, sizes and the care of horizontal milling machines; identification of the column, knee, saddle, table, arbor, spindle, overarm, arbor support and operating controls; plain milling; side milling

   (c) Drill Press: types, sizes and care of drill presses; identification of the base, column, table, quill, spindle and operating controls; twist drill parts. The pupil should be made familiar with the setups for the following operations: drilling with the work held in a vise; drilling with the work clamped to the table; drilling a blind hole; drilling a hole through the diameter of a cylinder; countersinking; drilling with the aid of a jig

   (d) Pedestal or Bench Grinder: instruction in safe operating practices - eye protection, position of work rests and guards; offhand grinding practices

(e) Power Saw: types and care of power saws; setting up and cutting work to length; use of cutting fluids

(f) Shaper: identification of the frame, column, ram, cross rail, saddle, table, table support, tool head and operating controls; shaping a plain surface; shaping work surfaces at right angles

5. Hot Metal Working: operating the forge or furnace; simple forging; simple hardening, tempering and case hardening

6. Finishing: draw filing, polishing, abrasive belt and disc grinding, rust proofing

Grade 10

SAFETY: The safety precautions that a good workman observes to ensure his personal safety and the well-being of others should be stressed.

1. Hand Tools and Bench Work

Types and uses of wrenches; types and uses of hand hacksaw blades; filing - removing burrs and sharp corners

2. Layout Work

The preparation of metal surfaces to facilitate layout. The use of additional layout tools such as a combination set, surface plate and templates

3. Measurement

The purpose, types, construction, care and reading of micrometers, protractors and graduated feed collars. The use of micrometers, protractors, graduated feed collars, plug, ring and thread gauges

4. Machine Tools

(a) Lathe: centre drilling; drilling in the lathe; cutting speed calculations; setting feeds and depth of cut; standard tapers, characteristics and use; taper turning attachment, calculations and application; short taper and angle turning using compound rest; the Unified Screw Thread System, nomenclature and calculations; cutting a Unified Screw Thread

(b) Drill Press: fractional, letter and number drills, selection and use; calculating tap drill size; drill holding devices; cutting speed calculations; selection of feeds for drilling; drilling to a depth; counterboring, countersinking and spot facing; use of cutting fluids

(c) Shaper: setting length and position of stroke; study of the cross feed mechanism; shaping a vertical surface; sequence of operations for shaping rectangular work

(d) Horizontal Milling Machine: changing an arbor; changing a cutter; sequence of operations for milling rectangular work; simple operations and calculations for the use of a dividing head set; cutting speed calculations

(e) Vertical Milling Machine: types, sizes and care of vertical milling machines; comparison of horizontal and vertical milling machines; identification of the column, knee, saddle, table, spindle and operating controls; milling a plain surface; milling work surfaces at right angles

(f) Pedestal or Bench Grinder: further instruction in safe offhand grinding practice

(g) Surface Grinder: types, sizes and care of surface grinders; identification of the main parts such as the wheel, spindle, table, cross slide, column and operating controls; the care and operation of magnetic chucks; demagnetizing the work; grinding plain and parallel surfaces to given dimensions

(h) Contour-cutting Band Saw: types, sizes and care of contour-cutting band saws, identification of the main parts; selection and use of blades; elementary sawing operations; band filing

5. Elementary Metallurgy: shop tests for identifying common metals; physical characteristics and uses of ferrous and non-ferrous metals; hardening and tempering; case-hardening

6. Hot Metal Working: forging, drawing and shaping

7. Fasteners: identification and use of fastening devices, e.g. rivets, bolts and nuts, cap screws, self-tapping screws, flat and lock washers, jam nuts, keys and special fasteners

8. Repair and maintenance: types of belts, selection, proper operation and repair; power transmission and speed changes; bearing types, grease and oil fittings and special lubrication systems

Grade 11

SAFETY: The importance of developing good safety habits should be emphasized.

1. Hand Tools and Bench Work

File types, sizes and cuts and their applications; precision filing of flat and irregular surfaces; types, characteristics, care and use of hand reamers; reaming parallel and taper holes; drilling with a portable electric drill

2. Layout Work

A study of the vernier principle and its application to measuring tools; layout work involving the use of the vernier protractor, the vernier height gauge, the surface plate, the surface gauge and precision V block

3. Measurement

The purpose and application of the vernier micrometer, inside micrometer, depth micrometer, vernier caliper, telescoping gauges, dial indicator, thickness gauges, profile gauges and gauge blocks; the care and storage of precision instruments

4. Machine Tools

(a) Lathe: the internal construction of the headstock, apron and tailstock; cutting speeds and feeds; truing and grinding of damaged centres; aligning centres; freehand form turning to a gauge; the angles and cutting action of lathe cutting tools; grinding lathe cutting tools; cutting right and left hand Unified threads, calculations and applications; three-wire method of measuring threads, calculations; taper turning and fitting to a gauge; steady and follower rest applications; drilling, boring and reaming; construction and use of common types of lathe mandrels; construction, use and care of collets; construction, types, use and care of 3-and 4-jaw chucks

(b) Drill Press: types of drill presses; clamping irregularly shaped work; drilling, countersinking and counterboring various metals; types, characteristics and use of machine reamers; application of jigs and fixtures to drilling operations; tapping attachments and their use

(c) Shaper: cutting speeds and feeds; cutting tools, materials, angles and cutting action; principle of fast return mechanisms; machining irregular and angular surfaces; serrating - method and applications; keyway cutting, external and internal

(d) Horizontal Milling Machine: speeds and feeds; work holding devices, such as clamps, vises and fixtures; types of milling cutters, selection and application; conventional and climb milling applications; side milling, straddle milling; sawing and slitting; milling machine attachments and their applications; end milling; form milling with form cutters; milling with fly cutters; direct and plain indexing; spur gear cutting; purpose and application of cutting fluids

(e) Vertical Milling Machine: types, sizes and care of vertical milling machines; milling a plain surface; milling surfaces at right angles; milling an angular surface; the use of collet chucks; the use of end mills; milling slots and keyways; application of slotting attachment

(f) Pedestal or Bench Grinder: grinding lathe and shaper cutting tools, grinding drills; grinding wheel construction, characteristics and marking systems; truing and dressing wheels, adjusting work rests

(g) Surface Grinders: names of operative parts; construction and care of magnetic chucks; truing and dressing a grinding wheel; demagnetizing; precision grinding of flat, and parallel surfaces; grinding work surfaces at right angles to each other; grinding angular surfaces

(h) Portable Grinders: grinding lathe centres in the lathe; external and internal grinding in the lathe; hand grinding at the bench

(i) Contour Cutting Band Saw: types, sizes and care of contour cutting band saws; identification of the main parts such as the table, upper and lower drive wheels, upper and lower blade guides, blade tension controls and other operative parts; cutting speeds for band sawing; types, sizes and selection of blades; butt welding of band saw blades; sawing of simple and complex contours; band filing; introduction to friction sawing

5. Metallurgy

The manufacture of irons and steels; the S.A.E. system for classifying steels; characteristics and applications of alloy steels; characteristics and applications of common non-ferrous metals; a study of the carbon content of steel and its effect in the hardening process; a study of the structural changes that occur in steel during the hardening, tempering, annealing and normalizing processes

Grade 12

SAFETY: Safe working procedures should be stressed at all times.

1. Hand Tools and Bench Work

Further practice to develop skill in precision filing; types of bearings - sleeve, babbitt and anti-friction - their lubrication; types of fits - running, push, driving, force and shrink; machine fitting including the scraping of flat and curved surfaces; lapping; the preparation and application of abrasives, preparation of laps and testing of lapped surfaces

2. Layout Work

Precision layout involving the use of tool-makers' buttons, trigonometrical calculations, sine bar, gauge blocks, vernier height gauge and precision planer gauge; cam layout, layout for eccentrics

3. Measurement and Inspection

Use of the gear tooth vernier caliper, thread micrometer, small hole gauges, gauge blocks, sine bar, sine plate, standard measuring rods, vernier height gauge, dial indicator, master square, comparator and other gauges; the measurement of surface finish; the functions of measurement and inspection in quality control

4. Machine Tools

(a) Lathe: eccentric turning; cutting Acme, Square, internal and multiple start threads; calculations for cutting the above threads; setting up and truing work with a dial indicator when work is held in a four jaw chuck or on a face plate; precision location of holes with the aid of toolmakers' buttons; application of form turning tools; the principle of reproducing a form on a work piece by using a tracing attachment; the principle of relieving form cutters using a backing-off attachment

(b) Horizontal Milling Machine: the calculations involved in differential indexing, helical milling and cam milling; precision hole location by use of measuring rods and dial gauges; the milling of helical gears, bevel gears, worm gears and cams; angular indexing; graduating flat and cylindrical surfaces; a study of tooth construction and materials for single and multi-tooth milling cutters; boring with a micrometer boring head; these operations should be precision milling operations incorporating the use of graduated collars, dial indicators, gauge blocks and toolmakers' buttons

(c) Vertical Milling Machine: jig boring; milling T slots and dovetails; use of the rotary table; the principle of form duplication using a tracing attachment; introductory die-sinking operations

(d) Radial Drill Press: types, sizes and care of radial drilling machines; the identification of the base, column, arm, spindle, drilling head and other operative parts; drilling, counterboring, countersinking and tapping; setting-up, clamping irregularly shaped work to avoid stresses

(e) Cylindrical Grinder: names of operative parts, adjustments and operation; setting speeds and feeds; parallel external and internal grinding; grinding external and internal tapers

(f) Cutter and Tool Grinder: names of operative parts, accessories, adjustments and operation; types and shapes of grinding wheels and applications; sharpening the following cutters - straight and helical toothed plain milling cutters, side facing cutters, end mills, reamers and form cutters

(g) Surface Grinder: types and selection of grinding wheels for various materials and applications; the application of the sine chuck, V block, magnetic V block and magnetic parallels; an introduction to form and crush dressing of grinding wheels; the application of cutting fluids to surface grinding

5. Metallurgy

A study of the principle and application of the thermocouple and pyrometer; an advanced study by experiment of the granular structure of heat-treated steels; further experiments in hardening, tempering, quenching, carburizing, annealing and normalizing; water, oil and air hardening of steels, their uses and heat-treatment; hardness testing methods such as Brinell, Rockwell and Scleroscope; experiments in tensile, compression and shear testing of samples and standard manufactured products

6. Carbide and Ceramic Tools

A study of the composition, purpose and application of carbide and ceramic cutting tools

7. Tool Making

The types of work done by the general tool-maker, jig and fixture maker, mould-maker, special machine builder; types of dies, moulds, jigs and fixtures; construction of punches and dies, jigs and fixtures and moulds

8. Hydraulics

A study of the principles involved in the hydraulic control of machine movements such as pumping mechanisms, valve mechanisms, hydraulic cylinders and hydraulic motors

9. A study of the principle and application of recent developments in the machine industry such as: electrical discharge machining, electro-chemical machining, numerical control of machine tools, powder metallurgy

PLUMBING

Four-Year Programme Grades 9, 10, 11 and 12

Grade 9

SAFETY: Safe practices in the use of tools and equipment should be stressed.

1. Threaded Pipe

   (a) General: weights, materials, types, nominal sizes and uses of black and galvanized pipe

   (b) Cutting: types of cutters and cutting procedures

   (c) Reaming: types of reamers, reasons for reaming and reaming procedures

   (d) Threading: pipe thread principles, the American standard pipe thread, pipe stock and die theory, types of stocks and dies, cutting oils

   (e) Measuring: thread engagement, fitting allowance, standard measuring practices; pipe project using ½" and ¾" pipe

   (f) Fittings: types, and uses of elbows, tees, bushings, unions and nipples, straight and eccentric couplings

   (g) Assembling: types of vises; types of wrenches; pipe joint cements and dry jointing materials

   (h) Valves: uses, operating principles and construction of the plug valve, the compression stop and the compression stop and waste

2. Copper Pipe

   (a) General: weights and types used in water piping

   (b) Fittings: cast and wrought fittings

   (c) Cutting and Reaming: tubing cutters and the hacksaw; cutting to measurement; allowance for fittings; methods of reaming

   (d) Assembly: oxidation; abrasive materials; cleaning the end of the tubing and the fitting; types of soldering fluxes and application; types of solders; soldering procedures; capillarity

3. Cast Iron Pipe

   (a) General: weights, sizes, types and uses

   (b) Fittings: types and uses of bends, offsets and branch fittings

   (c) Assembling: packing, pouring and caulking a vertical joint; safety precautions; caulking tools and their use

   (d) Soldering: tinning a soldering copper; oxidation; soldering fluxes for various metals; composition and melting points of soft solders; soldering lap seams on galvanized iron

4. Trade Theory

(a) General: types of measuring rules and their use, calculating a 45° offset, transfer of heat; types of firepots and torches; fuels; safety precautions

(b) Water Supply: water pipe layout; small pipe hangers; valve locations on a residential water supply system; range boilers and Hydro tanks; estimating material on a water pipe layout

(c) Maintenance: repairing and adjusting compression type valves and faucets

Grade 10

SAFETY: Safe working practices should be stressed.

1. Threaded Pipe

(a) General: layouts for roughing-in and finishing a water supply system; structural problems: cutting, notching, drilling joists and studs; grading and alignment of pipe, supports and hangers

(b) Valves: uses, operating principles and construction of gate and check valves

2. Copper Pipe

Weights and types of pipe; types of fittings used in drainage work; water piping installations; supports and hangers; protection from damage

3. Cast Iron Pipe

(a) Cutting: hammer and chisel method; safety precautions

(b) Assembling: packing, pouring and caulking a horizontal joint; use of a running rope; safety precautions

(c) Fittings: use and description of the Y, TY, tapped T (Single and Double), reducers and cleanouts

4. Lead Work

Tinning and using the soldering iron, preparing and making lap and butt joints in sheet lead

5. Trade Theory

(a) General: safe working practices concerning ladders, rope and knots, chemicals and gases; methods of operating propane and gasoline firepots and torches; safety precautions. Using a roughing-in book; calculating a two pipe 45° offset; estimating material

(b) Drainage: soil and waste stack layout; stack footings; hangers, rests and clamps; Plumbing Code Regulations; definition, purpose and types of plumbing traps; terminology

Grade 10

SAFETY: Safe practices in the handling of materials and in the use, care and maintenance of all tools and equipment should be emphasized.

1. Materials

   (a) Common sheet metals - (e.g. galvanized iron, tin plate, cold rolled steel, hot rolled steel, aluminum, copper, brass and stainless steel)

      Common properties - e.g. tenacity, malleability, conductivity, ductility, specific gravity, metallic lustre, fusibility, resistance to corrosion
      Methods of manufacture
      Approximate unit costs

   (b) Fluxes

      Types
      Special applications
      Preparation of fluxes for various metals

2. Measurement and Layout

   (a) Plane figures: circle and its parts, ellipse, pentagon

   (b) Bisection of arcs and angles

   (c) Dividing lines and circles into equal parts

   (d) Pattern development

      Principles of parallel line development; cylindrical pipes; elbows; roof flanges; scoop; tee joints, 45° and 90°, equal and unequal diameters
      Principles of radial line development; right cones; frustums; pyramids (square and hexagonal) rectangular pitched cover
      Simple duct layout; elbows, offsets and branches

   (e) Laying out

      Transferring dimensions from a blueprint or drawing to the sheet metal in preparation for cutting
      Use of indentations for locating bending lines
      Procedures for determining circumferences of circles mathematically; step-off and circumference rule methods
      Perimeters; areas
      Adding seam allowances for double seams, grooved seam and Pittsburgh lock
      Drive and "S" cleats

3. Hand Processes (Tools and Operations)

   (a) Cutting

      Use of aviation, scroll, straight and curved snips

(b) Folding and forming: use and recognition of bench stakes and improvised stakes in forming cylindrical and conical-shaped articles

(c) Riveting

  Blind riveting
  Pop riveting, use of cranked pliers
  Method of removing rivets

(d) Soldering

  Selection of soldering iron
  Tinning a soldering iron for overhead use
  Selection of proper fluxes
  Study of melting points of various solder alloys
  Tinning metals in preparation for soldering
  Proper application of solder to various types of seams: sweating; soldering dissimilar metals; soldering vertical seams

(e) Double and bottom seaming

  Metal allowance required
  Preparatory folds
  Method of turning seam with mallet
  Drawing metal back from folds
  Squaring and tightening seams in both rectangular and cylindrical objects

(f) Drive cleats and "S" cleats

  Uses, methods of forming

4. Machine Processes (Machines and Operations)

(a) Continued use of squaring shears, bar folder, hand brake, box and pan brake for further fabrication

(b) Slip roll former: cylinders and conical articles; wire; wired edges

(c) Wiring machine: capacity, completing wired edges on flat and cylindrical objects

(d) Turning machine: capacity, turning edges on flat and cylindrical work; preparation for wired edges

(e) Easy edger: capacity, burring edges on flat curved surfaces

(f) Lockformer: capacity, attachments; forming Pittsburgh lock and flange

(g) Wire bending machine: capacity, uses

(h) Spot welder: capacity, operation and adjustments

Grade 11

SAFETY: Safe practices in the use, care and maintenance of tools and equipment should be stressed.

1. Sheet Metal Problems

Linear, angular, surface and capacity measurements; formulae for squares, rectangles, triangles, parallelograms, trapezoids, circles, regular hexagons and ellipses; estimating material costs; ratio and proportion; powers and square root; seam and edge allowances

2. Pattern Development

Scale drawings should be completed of all developments. All patterns developed are to be regular trade size and fabricated in metal.

(a) Geometric problems: erection of perpendiculars, bisection, construction of regular polygons, tangents, construction of the ellipse

(b) Parallel line method: developments such as three- and four-piece round elbows; square elbows; ordinary tees and Y branches; trough and coping mitres (inside, outside, face); conductor heads and finials; register boxes; chimney cap or ventilator head; flashings (chimney and walls)

(c) Radial line method: developments such as funnels, regular and flat one side; flaring pan and pitched covers; tapering pails and measures; reducers

(d) Triangulation method: principles; developments such as forge and exhaust hoods, rectangular to round fittings (symmetrical and non-symmetrical), square to square transitions, rectangular reversibles, reducers, furnace boots

3. Duct Construction

Low velocity systems: blueprint symbols for ventilating and air conditioning systems; gauges and types of metals and materials; cross and longitudinal seams; hangers and supports; elbows, tapers and offsets; streamlined branches and tee connections

4. Seams and Seaming Allowances

Seams: standing, double, grooved, Pittsburgh lock, riveted, lined and reinforced; fire door seams; amount of material required; common uses and advantages in fabrication and installation

5. Machine Processes

(a) Adjustable bar folder: adjustment for tension on various gauges of metal, radius folds

(b) Brakes: hand, box and pan types, tension adjustment and bending various gauges of metal, use of moulds, special fingers for radius bends

(c) Slip roll former: forming wired articles, flaring articles

(d) Beading and crimping: ornamenting, reinforcing and reducing cylindrical and conical shaped objects

(e) Elbow edging machine: forming edges for round elbows

(f) Unishear, ring and circle shear: cutting patterns

(g) Bar and tube bender: setting up and forming wire, rod and bar stock

(h) Spotwelder: setting up and changing tips for various jobs, controls and their functions, care and adjustment

(i) Continued use of squaring shears, brakes, wiring machine, turning machine, easy edger and lockformer for further fabrication

(j) Power machines: It is desirable that students obtain some familiarity with power-operated equipment.

6. Hand Processes

(a) Soldering: forging soldering irons for various applications; soldering vertical and overhead seams; soldering various metals such as stainless steel, copper, lead and zinc

(b) Cutting: use of double cutting snips, care and sharpening of cutting blades

(c) Riveting: use of aluminum, brass and pop rivets

7. Air Conditioning

If a special shop for Air Conditioning and Refrigeration is available, Air Conditioning may be given as a related shop, if not Air Conditioning may be included in Sheet Metal Course. Refer to the Air Conditioning and Refrigeration Course and select suitable topics.

Grade 12

SAFETY: Safe practices in the use of tools and equipment should be observed at all times.

1. Pattern Development

Scale drawings should be completed of all developments. All patterns developed are to be regular trade size and fabricated in metal.

(a) Parallel line method: developments such as coping and flashing, intersections on irregular surfaces, elbows and branches, round and rectangular pipe and duct fittings, louvres

(b) Radial line method: developments such as round and rectangular eccentric tapers, stack heads, tapered elbows, cyclone separator

(c) Triangulation method: developments such as eccentric transition fittings, machine and forge hoods, Y branches from round pipes of equal and unequal angles and diameters, rectangular Y branches with different areas for ventilation systems, regular and compound offsets, transition elbows

2. Duct Construction

Low velocity systems: dampers, access doors and fire doors, louvres and screens, exhaust hoods and fume hoods, goosenecks, belt guards, flexible connections and acoustical treatment, casings and housings

3. Seams and Joints

(a) Blower and ventilation systems: all seams involved in the fabrication and assembling of ducts and pipes such as riveted, slip double seam, hammered lock, drive cleat, S-cleat, standing seam and slip lock

(b) Roofing and ceiling: cross and longitudinal joints for flat lock, standing seam and batten roofing; expansion joints; box gutters; types of joints used and methods of manufacture for metallic ceiling, roofing and siding

4. Hollow Metal Work

Blueprint reading; metal thicknesses; bend allowances for sharp angle, and radius bends; forming procedure; methods of joining and seaming such as spot welding, riveting and welding (arc and acetylene)

5. Oxy-Acetylene Welding (Optional but recommended)

Note: Welding should be taken in the welding shop if one is available.

History of oxy-acetylene welding; safety precautions; glossary of terms - welding and cutting; care and use of equipment - tanks, gauges, torch tips, valves; setting up and turning off equipment; pressures; tip sizes and material thicknesses; chemistry of flame (neutral, oxidizing and carbonizing flames); corner, butt, lap and fillet welds; welding and brazing light sheet metal and small structural shapes

6. Oxy-Acetylene Cutting (Optional but recommended)

Principles of oxy-acetylene cutting; setting up equipment; pressures, cutting tips; cutting along a given straight line freehand and with a guide bar; cutting a circular hole in light gauge sheet metal

7. Arc Welding (Optional but recommended)

Fundamentals of arc welding; arc welding equipment; welding methods; safety precautions; electric motor driven arc welding machine, welding generator - current control; polarity (straight and reversed); electrode holders; types of electrodes; colour identification of electrodes; numerical classification; development of skill in striking and holding an arc; welding symbols; principles of carbon arc welding

8. Machine Operations

(a) Hand brake and box and pan brake: use of moulds for forming cornices and copings, use of special forming attachments

(b) Rotary machines: wider use of the elbow edging, wiring, turning and easy edger machines in the fabrication of pipe and duct fittings; adjusting heads for end-play; correct position for various gauges of metal used

(c) Foot squaring shears: replacing, lining up and adjusting blades for shearing light and heavy metals

(d) Pittsburgh lock former: adjusting for various gauges, special attachments

(e) Power machines: It is desirable that students obtain some familiarity with power-operated equipment.

9. Sheet Metal Problems

Stretchout lengths for elbows, offsets and pipe lengths; calculating diameters, lengths and areas for transition and Y fittings; estimating material and labour costs

10. Exhaust, Blower and Ventilation Systems

(a) Principles of air flow

(b) Air flow characteristics of blowing and exhausting

(c) Pressure drop through duct work

(d) Layout of system from blueprints

(e) Study of materials used in such systems

(f) Capture and carrying velocities

(g) Sizing of lines

(h) Cyclones and dust separators

(i) Fan types, sizes and application

(j) A study of the testing and balancing of dust collection and conveying systems; test instruments

(k) Inspection and maintenance procedures

11. Air Conditioning

If a special shop for Air Conditioning and Refrigeration is available, Air Conditioning may be given as a related shop, if not Air Conditioning may be included in Sheet Metal Course. Refer to the Air Conditioning and Refrigeration Courses and select suitable topics.

WELDING

Four-Year Programme

Electric Arc Welding

Oxy-Acetylene Welding

Some schools in Ontario have separate shops for electric arc welding and oxy-acetylene welding and this course outline is set out in two separate units. For the teacher who has the combined shop the required information should be taken from each unit.

WELDING - ELECTRIC ARC

Four-Year Programme Grades 9, 10, 11 and 12

Grade 9

Note: If the pupils have not previously been instructed in the safe operation of the acetylene equipment as outlined in the Grade 9 Oxy-Acetylene course, thorough instruction should be given.

SAFETY: The pupils should be made familiar with the shop routine and the safe operations of all the equipment.

1. Introduction

Definition and history of arc welding

2. Welding Equipment

(a) Hoods: method of inserting clear and coloured glass; shade of lens, composition of helmets

(b) Cables: ground and electrode connections and method of securing

(c) Holders: different types and sizes

3. Energy Supply

Simplified explanation of current and voltage and their relation to good welding; simple welding circuit; method of obtaining current settings on different welders

4. Fundamentals of Welding

(a) Striking an arc by scratching and tapping

(b) Electrode angle, sound of arc, speed of travel, formation of crater, frozen electrode, arc length

(c) Types of weave motions, uniformity and appearance

5. Electrodes

The use of E6012 or E6013 electrodes; colour, identification, power supply

PRACTICAL WORK

1. Welding Operations

Note: Stress the use of the welder's chipping hammer and wire brush to clean all deposits.

(a) Set up power source ready for operation; check main power switch, secure ground and electrode connections, adjust current setting

(b) Insert clear and coloured glass in helmets in proper locations

Grade 12

SAFETY: Review the safety precautions previously outlined.

1. A review of the more difficult practical exercises in Grade 11

2. Types of Welding Machines

   A comparison of the sizes, construction, characteristics, advantages and disadvantages of A.C. transformer, D.C. motor generator, D.C. selenium rectifier and A.C. - D.C. transformer - rectifier units

3. Vertical Welding (Upward and Downward)

   Angle of electrode, current setting, speed of travel, typical weave motions

4. Welding of High Carbon Steels

   Types of high carbon steels, types of electrodes, procedures in welding high carbon steels, defects encountered in welding these steels

5. Welding of Cast Iron

   (a) A review of composition of cast iron

   (b) Selection of electrodes for cast iron welding - ferrous and non-ferrous electrodes

   (c) Preparation of casting - chipping, drilling and studding

   (d) Pre-heating and post-heating procedures

   (e) Welding technique

6. Carbon Arc Welding

   Explanation of carbon arc method - graphite and carbon electrodes; electrodes - sizes and current values; use of backing strips; operational characteristics

7. Overhead Welding

   Safety precautions; angle of electrode; current values; position of the operator; types of weave motions; location of the individual passes

8. Hard Surfacing

   Types of hard surfacing electrodes and their uses; preparation of surface by removal of outside skin; method of depositing beads

9. Pipe Welding

   (a) Types of pipe - refer to Grade 12 Oxy-Acetylene Welding course, Four-Year Programme

   (b) Electrodes: types and sizes

   (c) Use of backing rings and inserts

(d) Welding procedures

(e) Method of testing welded specimens

10. Aluminum Welding

Aluminum and its alloys, metallic arc welding of aluminum, type and composition of electrode, preparation of plates, welding procedures, flux removal

11. Advanced Expansion and Contraction

Effects of expansion and contraction on welded frames, wheels and gears

12. Elementary Metallurgy of Iron and Steel

Refer to Grade 12 Oxy-Acetylene course of study, Four-Year Programme

13. Tungsten Inert Gas Welding - A.C. and D.C. Current

(a) Inert gases: argon, helium, neon, krypton, zenon and their uses in shielding

(b) Description of T.I.G. process

(c) Diagram of the T.I.G. torch

(d) Size of tungsten electrodes and corresponding colletts and ceramic cups

(e) Description of high frequency equipment, solenoid gas valves and flowmeters

(f) Metals that can be T.I.G. welded

14. Estimating Electric Welding Costs

Method of calculating number of pounds of electrodes per foot of weld, cost of electrical energy; labour costs and allowance for overhead expenses and depreciation

15. Structural Steel Welding

Study of structural steel shapes, angle iron, channel iron, I-beams, H-beams; sizes and weights of structural steel shapes; welded joints used in structural steel welding; layout and preparation of simple joints; use of gusset plates in fabricating structural steel shapes

16. Downhand Welding

Angle of electrode; proper current and speed of travel; advantages and disadvantages of downhand welding

17. Special Welding Applications

Note: If the following equipment is not available the different types of machines and the method of operation should be discussed.

Submerged arc welding; semi-automatic and automatic welding of aluminum, stainless steel and copper; carbon dioxide process; inert arc spot welding

PRACTICAL WORK

1. Vertical Welding

   (a) With ¼" mild steel plate in a welding jig, the running of parallel beads using 1/8" and 5/32" reverse polarity electrodes

   (b) Preparing and welding a vertical lap joint and a vertical tee joint with same electrodes and using the same material as in (a) above

   (c) Preparing and welding a single V butt joint on 3/8" mild steel plate with and then without a backing strip and 1/8" reverse polarity electrodes. Test by guided bend method

   (d) Repeat the above exercises using 5/32" reverse polarity electrodes

2. Overhead Welding

   The overhead welding operations to be performed are the same as in 1 above but with the plates in the overhead position

3. Pipe Welding

   Welding a 4" or 6" diameter pipe with heavy wall thickness using reverse polarity electrodes. Pipe may be rotated for welding. Cut out samples for testing by the guided bend method. Repeat the above exercise but have the pipe permanently fixed for an all position weld

4. Downhand Welding

   Making a vertical downhand weld on light gauge plate using 1/8" and 5/32" diameter electrodes

5. Cast Iron Welding

   Preparing a butt joint on a ¼" to 3/8" casting using ferrous and non-ferrous electrodes

6. T.I.G. Welding

   (a) Connecting the specialized equipment to the existing source for T.I.G. welding

   (b) Running lines of fusion on 2S or 3S aluminum using different sizes of tungsten

   (c) Preparing and welding a corner, lap, tee and butt joint on the same material as above, using the proper size of tungsten for each operation

   (d) If stainless steel is available repeat the above procedures

7. Structural Steel Welding

   (a) Lay out and weld one angle iron frame using mitred corner joints

   (b) Reinforce an angle iron or I-beam welded joint by preparing gusset plates and then welding in place

WELDING - OXY-ACETYLENE

Four-Year Programme Grades 9, 10, 11 and 12

Grade 9

SAFETY: The oxygen and acetylene gas used in this type of welding may be supplied by a manifold system or a tank system. The pupils should be made familiar with the shop routine and safe operation of each type of equipment.

1. The Development of Oxy-Acetylene Welding

   The definition and history of oxy-acetylene welding; the introduction of the first acetylene welding torch; the importance of oxygen and acetylene gas in the flame; properties and methods of manufacturing oxygen and acetylene; the proper ratio of oxygen and acetylene to produce good combustion

2. Equipment

   (a) Discussion of colour standards, fittings and threads, protective clothing, goggles, tools

   (b) Cylinders: construction of commercial cylinders; modern use of liquid oxygen; safety features and method of testing for leaks in cylinders and manifold

   (c) Pressure regulators: types, function (tracing path of gases from cylinders through the regulators to lines); creeping regulator; diaphragm, adjusting screw, tension spring, pressure gauges; safety devices - colour, nuts, threads; rules for avoiding damage to regulator

   (d) Welding torches: different types; mixing head and interchangeable tip system; care of torch and tips; function

3. Types of Flames

   (a) Carburizing, neutral and oxidizing; temperatures and their effect on the metal

   (b) Comparison between flashback and backfire; causes and remedies, safety rules

4. Basic Joints

   (a) Types, proper alignment, method of tacking, selection of proper tip for joint being welded, method of testing welded joints

   (b) Common welding defects: undercut, adhesion, poor penetration, lack of fusion, porosity

5. Filler Rods

   Selection of types and sizes for mild steel only

6. Introduction to Oxy-Acetylene Cutting Process

   Elementary explanation of oxy-acetylene cutting; brief description of the cutting torch; method used for cutting a straight line on mild steel plate, using the freehand technique

PRACTICAL WORK

1. Welding Operations

   (a) Proper use of machinist's hammer, centre punch, scribers, dividers, square

   (b) Laying out straight lines and the use of soapstone for marking steel plate

   (c) Assembling equipment - hose lines, regulators, torch

   (d) Opening and closing down oxy-acetylene equipment

   (e) Obtaining the three types of flames and showing their effect on mild steel plate

   (f) Position and torch movements when running lines of fusion on thin gauge steel (Discuss the relation of penetration and fusion for good welding procedures)

   (g) Running lines of fusion on mild steel plate without and with filler rod

   (h) Running weave motions on mild steel plate with filler rod

   (i) Preparing and making a corner weld without and with filler rod

2. Cutting Operations

   Hand cut straight lines on ¼" mild steel plate; use of soapstone, ruler and centre punch

Grade 10

SAFETY: Review the safety precautions previously outlined.

1. Review essential topics of Grade 9 Acetylene Welding course

2. Manual Gas Cutting

   Safety precautions; theory of cutting steel; the cutting torch, internal structure and function; chart for selecting tips, sizes and gas pressures; cutting attachment for combination cutting and welding torch; circle cutting attachment for hand cutting torch; circle cutting and piercing holes in heavy plate; straight and bevel cutting using a guide bar; common cutting faults

3. Machine Gas Cutting

   Structure and function of machine and its use in industry; chart for selecting tips, gas pressures and speed of travel; changes in procedures for bevel cutting and radius cutting

4. Ferrous and Non-Ferrous Metals

   Identification: spark test for low carbon steel, high carbon steel and cast iron; fracture test for grain structure; colour; chip test, characteristics of the chips; colour test of copper, bronze and brass; physical properties of metals such as elasticity, toughness, hardness, brittleness and malleability

5. Elementary Principles of Expansion and Contraction

   Expansion in sheet metal, distortion and warping of edges; upsetting; effect of heating in localized areas; effect of expansion and contraction on welded joints

6. Manufacture of Iron and Steel

   (a) The principle and operation of blast furnace, cupola, open hearth furnace, Bessemer converter and electric furnace

   (b) Manufacture of: wrought iron; gray, white and malleable cast iron

   (c) Classification of steels by S.A.E. system

7. Fillet Welding

   Definition, parts of a fillet weld; types of fillet welds - convex, concave, defects in fillet welds

8. Measuring Stock for Bending

   Method used to calculate material required for a given circle, right angled frame and a chain link

9. Elementary Heat Treatment of Metals

   Annealing, normalizing, hardening and tempering; heat treatment of small tools by air and oil hardening

PRACTICAL WORK

1. Welding Operations

   Note: A review of the more difficult exercises of the Grade 9 Oxy-Acetylene course.

   (a) Running lines of fusion with a 1/8" filler rod on #11 gauge mild steel plate

   (b) Preparing and welding a square butt joint with the same filler rod as above and on the same material. Hammer test completed weld

   (c) Preparing and welding a lap joint and a flush tee joint on #11 gauge mild steel plate using 1/8" filler rod. Hammer test completed weld

   (d) Preparing a double V butt joint on a small diameter shaft and welding, using 3/32" or 1/8" filler rod

   (e) Building up a small mild steel shaft with 1/8" mild steel filler rod

2. Hand Cutting Operations
   (a) Cutting straight lines and 30° or 45° bevels using freehand method
   (b) Laying out and cutting a circle using the freehand method
   (c) Hand cutting a circle using a radius bar
   (d) Making a bevel cut using an angle bar
   (e) Piercing holes in heavy plate

3. Machine Gas Cutting
   (a) Straight line cutting and bevel cutting
   (b) Circle cutting using gas cutting machine with radius rod

Grade 11

SAFETY: Discuss safety precautions previously outlined.

1. Review practical exercises and essential topics of Grade 10 Oxy-Acetylene Welding course

2. Operation and Maintenance of Manifold System

   Safety features of a manifold system, hydraulic backpressure valves, check valves, type of piping, bursting discs and flashback arresters, construction of manifold rooms for acetylene and oxygen

3. Acetylene Generators

   Low pressure and high pressure

4. Welding Equipment

   Construction of high pressure welding torches, cutting torches, combination type torch and regulators

5. Simple Repairs to Oxy-Acetylene Equipment
   (a) Replacing: valve seats and ruptured regulator diaphragms; "o" rings in welding torches, Re-seating needle valve seats and replacing ball seats
   (b) Re-conditioning welding and cutting tips; use of tip drills and reamers
   (c) Glyerine or glycerine base lubricants
   (d) Testing for gas leaks

6. Types and Uses of Filler Rods

   Ferrous rods, composition and uses of high test and nickel steel

7. Advanced Principles of Expansion and Contraction

   Causes of distortion, means of preventing distortion by jigs, tacking, clamping, preheating and postheating

8. Fusion Welding of Heavy Plate

   A review of the preparation of edges; forehand and backhand method; wash welding

9. Fusion Welding of Cast Iron

   Review of types of cast iron; preparing a casting for welding; strengthening cast iron by using studding technique; composition of flux used for welding cast iron; preheat and postheat procedures; visual and destructive testing of completed welds; analysis and sizes of cast iron filler rods

10. Bronze Welding

    Definition and principles of bronze welding, uses of bronze welding, advantages - disadvantages, bronze welding rods, uses, sizes, melting points, preparation of parts to be bronze welded, technique of bronze welding - flames, fluxing, tinning; methods to be used to determine correct temperatures; building-up with bronze filler rods; uses of carbon rods, paste and asbestos

11. Silver Brazing

    (a) Definition and application of silver brazing; metals that can be brazed; uses in industry

    (b) Types, compositions and characteristics of silver brazing alloys

    (c) Preparation of parts before brazing; types of torches; procedures

PRACTICAL WORK

1. Welding Operations - Welding in the Down Hand Position

   (a) Preparing and welding a full open corner joint and a single V butt joint on $\frac{1}{4}$" mild steel plate using 1/8" or 3/16" filler rod and forehand method

   (b) Repeat using a backhand technique

   (c) Welding double lap joint on $\frac{1}{4}$" mild steel plate using the same filler rod

2. Vertical Welding

   Note: The following vertical welds should be done on #11 gauge mild steel plate using 3/32" or 1/8" filler rod as specified

   (a) Running parallel stringer beads from bottom of plate to top without and with filler rod

   (b) Preparing and welding a full open corner joint without and with filler rod. Hammer test

(c) Preparing and welding a single fillet lap and tee joint. Hammer test

(d) Preparing and welding a square butt joint. Hammer test

3. Welding Heavy Plate in Vertical Position

Preparing and welding a lap, tee and single V butt joint using ¼" mild steel plate and 1/8" filler rod

4. Bronze Welding

Note: The following exercises should be done in the flat position on 1/8" mild steel plate unless otherwise specified.

(a) Running parallel beads using 3/32" bronze filler rod

(b) Running a single pass fillet lap and tee weld using 1/8" bronze filler rod

(c) Preparing and welding a square butt joint using 1/8" bronze filler rod (slightly bevel the edges)

(d) Bronze welding a broken grey iron casting

(e) Bronze weld a single V butt joint on mild steel plate

5. Fusion Welding Cast Iron

Note: Exercises on cast iron should be performed on prepared cast iron flats.

6. Cutting Exercises on Cast Iron

Practical cutting exercises on cast iron to familiarize the pupils with this type of work

7. Silver Brazing Exercises

Silver braze lap joints on mild steel, copper and stainless steel

Grade 12

Note: Review the more difficult practical exercises of Grade 11.

1. Piping

(a) Types of pipe: standard mild steel, heavy duty, extra heavy, tubing, seamless pipe, welded pipe, cast iron, copper and brass

(b) Methods used to join pipe: pipe threads, flange fittings, welded fittings, advantages and disadvantages of the above methods

(c) Small and large diameter piping: industrial uses, dimensions of standard pipes and tubing

(d) Methods of cutting pipe: mechanical and oxy-acetylene cutting (hand and machine)

(e) Preparation of pipe for welding: beveling; spacing and tack welding; clamping, vee blocks, rollers; use of lead and brass sheeting to prevent surface pitting; use of backing strips

(f) Filler rods used for oxy-acetylene welding of pipe: types and sizes

(g) Expansion and contraction of pipe: linear expansion; methods used to counteract expansion and contraction; expansion bends; expansion joints

2. Pipe Joints

Butt joint, straight; 2 piece, 90 degrees; 3 piece, 90 degrees; 2 piece, 45 degrees; tee joints, lateral Y and true Y; layout and use of templates; contour marker; wrinkle bending

3. Aluminum Welding and Brazing

Production of common aluminum alloys; cast and drawn aluminum; heat treatment, annealing and normalizing; filler rods for cast and drawn aluminum; brazing rods; welding and brazing fluxes; flame adjustment; preparation, cleaning and methods of supporting; welding technique; temperature indicators, salt, oil, pine-wood stick; necessity for removal of flux after welding

4. White Metal

Uses, advantages and disadvantages; alloys of white metal; cleaning and preparation, filing, grinding, supporting; flame adjustment and control; use of spatula; filler rods, sizes and composition

5. Hard Surfacing

Definition and applications, types of rods and hard surfacing inserts, building up cutting tools with hard facing rods, preparation of surface, flame adjustment, technique of applying hard surfacing rod, use of silver brazing for applying hard face inserts

6. Elementary Metallurgy of Iron and Steel

(a) Pure iron: allotropic forms, critical points and structures of pure iron

(b) Structure of metals: atomic structure, crystallization, space lattice, process of solidification of a metal, crystals and grains, effect of cooling rate

(c) Structure of steels: eutectoid steel, hypo-eutectoid steel, hypereutectoid steel

(d) Properties of non-ferrous metals: brass, bronze, copper

(e) Stainless steels: ferritic, martensitic, austenitic

7. Special Applications

Arc-air cutting, oxygen lance cutting, powder flame cutting

8. Estimating Costs

Methods of determining costs in welding: determining pounds of rod per foot of weld; gas consumption; labour costs; overhead expenses

PRACTICAL WORK

1. Welding Operations

   (a) Gas weld butt joint on 2" pipe (Pipe may be rotated)

   (b) Same exercise as above except the pipe is to be placed in a fixed position for an all position weld

   (c) Make a layout of a 2 piece 90 degree elbow on 2" pipe; prepare and weld

   (d) Gas weld a 3 piece 90 degree elbow on the same material

   (e) Make a layout of a straight tee point on 2" pipe and weld together

   (f) Prepare and weld a lateral Y of 2" pipe

   (g) Prepare and weld a true Y of 2" pipe

   (h) Bronze weld a galvanized pipe in all positions

2. Aluminum Welding

   (a) Run lines of fusion on 1/8" 2S or 3S aluminum using 1/8" aluminum rod

   (b) Make a butt joint of the same material and weld together

   (c) Prepare and weld a corner joint of aluminum

   (d) Prepare and weld a lap joint of aluminum

   (e) Aluminum braze a tee joint on 1/8" 2S aluminum using a 1/8" aluminum brazing rod and flux

3. White Metal Welding

   Prepare and weld a butt joint on a white metal casting

4. Hard Surfacing

   (a) Build up a wear-resistant surface using air-hardening filler rods

   (b) Repair cutting tool edges with hard surfacing materials

   (c) Silver braze hard face inserts

WOODWORKING

Four-Year Programme Grades 9 and 10

Grade 9

This course is general in nature and provides an introduction to further study in the areas of Building Construction, Cabinet-Making and Millwork or Pattern and Casting Processes.

Emphasize in project study the interpretation of drawings, design, bill of material, order of operations, layout and joint construction.

SAFETY: Good safety practices in the use of hand and power tools should be emphasized. The use of push sticks, adequate equipment guards and safety glasses and the wearing of proper clothing should be stressed.

1. Materials

   (a) Lumber: classification of lumber - soft-and hardwoods, general purpose and miscellaneous woods; defects; stock sizes; units of measurement

   (b) Adhesives: source, characteristics, application

   (c) Hardware: various types of nails, wood screws, hinges and catches

   (d) Finishing: elementary supplies (stain, shellac, paint and enamel) A dicussion of the methods used in industry for applying finishing materials

2. Hand Tools and Operations

   (a) Laying out: use of try-square, marking gauge, marking knife and dividers

   (b) Sawing: rip and cross-cut

   (c) Planing: surfaces, angles, chamfers, rounds

   (d) Chiselling: chamfers, rounds, paring, cutting a mortise; use of mallet

   (e) Shaping: use of coping saw, spokeshave

   (f) Boring: use of various boring bits, brace, drill

   (g) Fastening: use of nails, wood screws, fasteners; use of various types of holding devices

   (h) Sanding: use of coated abrasives, flint and garnet

   (i) Sharpening: whetting plane irons and chisels

3. Machine Tools and Operations

   Every machine must be properly guarded and all safety precautions should be taken when operating woodworking machines.

   (a) Safety: stress use of push sticks, protective devices, adjustments and correct method of operation

(b) Band Saw: cutting regular and irregular shapes

(c) Drill Press: boring, countersinking, counterboring

(d) Jig Saw: sawing simple curves, interior, exterior

(e) Jointer: face and edge cuts

(f) Lathe: rough and finish turning, shoulder and taper turning, beads, curves, various chisels, face-plate turning, use of calipers, templates, patterns

(g) Mortiser: vertical mortising

(h) Planer: thickness, surfacing

(i) Portable Router: shaping simple moulds with a set fence

(j) Radial Saw: cutting to length

(k) Sanders: sanding flat and curved areas

(l) Variety Saw: parallel ripping

4. Finishing Processes

(a) Preparation of the project for and the application of stain, shellac, varnish, brushing lacquer and wax, paint and enamel; care of brushes

(b) Application of finished hardware

Grade 10

This is a basic course in Woodworking and additional topics should be selected from the Grade 10 course outlines in Building Construction, Cabinet-Making and Millwork and/or Pattern and Casting Processes to meet the needs of the local community.

In all projects further emphasis should be placed on the interpretation of drawings, - design, accurate layout, estimating materials, the order of operations and joint construction.

SAFETY: Good safety practices in the use of hand and power tools should be emphasized. The use of push sticks, adequate equipment guards and the wearing of safety glasses and proper clothing should be stressed.

1. Materials

(a) Lumber: kinds, classification, grades, plywoods and composition boards, methods of sawing and seasoning, unit calculations and prices, conservation of natural resources, chemical composition of woods, elementary physical and mechanical properties of wood

(b) Abrasives: types, grades, classification, manufacture

(c) Adhesives: comparison and characteristics of various kinds

(d) Finishing: natural and synthetic types

2. Hand Tool Operations

   (a) The extension of and improvement in the use of hand tools as outlined for Grade 9

   (b) Use of special planes, e.g. block, rabbet, router

   (c) Grinding and whetting

   (d) Use of layout tools, e.g. framing square, trammel points

   (e) Clamping and gluing procedures

3. Machine Tools, Operation and Technology

   The proper care, operation and guarding of all machines must be stressed.

   (a) Safety: protective devices and precautions

   (b) Band Saw: economical use of wood to avoid waste by overlap layout method, use of jigs

   (c) Boring: stationary and portable types of machines

   (d) Grinder: grinding edge tools, angles for cutting and turning tools

   (e) Jointer: truing face side and face edge, sizing

   (f) Lathe: spindle, face and chuck turning; turning to a template, sanding, polishing

   (g) Mortiser: hollow chisel or chain type

   (h) Planer: dressing to thickness, squaring, tapering, surfacing thin stock

   (i) Portable Router: the use of a fence and pilot cutters

   (j) Portable Sabre Saw: making various cuts

   (k) Radial Saw: cutting lengths, angles and dadoes

   (l) Sanders: drum, disc, spindle, oscillating and belt

   (m) Variety Saw: identification of various blades; cutting to width and length; special cuts - taper, tenon and dadoes

4. Finishing Processes

   (a) Water, oil and non-grain raising stains

   (b) Resin, natural and synthetic types of stains

   (c) Fillers for open grain woods

   (d) Shellacking, varnishing, water and oil rubbing

WOODWORKING - BUILDING CONSTRUCTION

Four-Year Programme Grades 10, 11 and 12

Grade 10

To ensure adequate coverage of the subject, additional topics should be selected from the Grade 10 Woodworking course.

Where possible a suitable structure of adequate size to illustrate building principles and erection procedure should be built to provide student participation and practical application.

SAFETY: Safe practices in the use of tools and equipment should be stressed.

1. Planning

   (a) Blueprint reading: an elementary knowledge of interpretation as applied to plot plan layout, symbols, plans, elevations and sections

   (b) Scheduling as applied to the various sub-contractors and recognition of acceptable building standards

   (c) Materials: concrete and concrete blocks; structural wood members (sizes and characteristics); clay, stone and concrete products

   (d) Types of construction: frame, brick, solid masonry

2. Practical Application for Frame Construction

   Good nailing practices; fastening devices; box sill construction; beams, columns, joists, bridging; sub-flooring - conventional and plywood; wall covering - sheathings and siding; ceiling joists and spans, types and sizes; roof framing - simple gable, collar ties, roof terminology; cornice construction (simple); roof covering, sheathings and shingles; doors and windows - types and framing details

3. Construction Tools

   (a) Layout: steel tapes, lines, levels, plumb-bobs, straight edges, squares

   (b) Framing square: graduations and tables as applied to common rafter

   (c) Portable saws: safety and application

   (d) Hand tools and machines: refer to Grade 10 course in Woodworking where applicable

Grade 11

This outline sets forth the practices and techniques essential in house building. Carpentry is recommended as the basis of instruction.

In the advanced study of building construction, increased emphasis is to be placed on the theoretical aspect, although some topics may well be stressed through practical application in shop work. A full size building project should be constructed if possible.

SAFETY: Stress safe practices in the use of tools and power equipment.

1. Interpreting Plans and Specifications

   (a) An advanced study of blueprint reading

   (b) Estimating quantities and material

   (c) Local building codes: by-laws; restrictions

   (d) C.M.H.C. standards: National Building Code

2. Construction Fundamentals and Procedure

   (a) Layout of site: lot lines and batter-board; stakes; sizes and squaring

   (b) Excavation: soil conditions; grade lines

   (c) Concrete forms: footings; walls

   (d) Foundation materials: concrete mixes; blocks; anchors

   (e) Waterproofing and drainage

   (f) Framing

      Floor construction: sill plates; girders; joists; hangers; headers; bridging; stair openings (wells); sub-flooring

      Wall construction: platform, balloon, bracing, plates, studs; girths; headers; trimmers; cripples

      Sizes of rough openings for doors and windows

      Prefabrication

      Exterior wall coverings, finish and trim: sheathings and composition boards, vapour barriers; cornice and roof overhang; types of sidings; types of doors and windows

      Roof construction: terminology; framing square; gable, hip, valley, sheathing, shingles; flashings; chimney saddles

Interior wall finishing and covering: insulation and ventilation; lath and plaster (expanded metal, gyproc); dry wall construction (plywood, composition); trim (casings and baseboards)

Stair building: straight flight: open and housed stringers; handrails

Fixtures: built-ins; cupboards

Finished flooring: hardwood; tile; ceramic

3. Services

(a) Correlation and co-operation with sub-trades: masonry. electrical, plumbing, heating, communications, painting and decorating

(b) Scheduling and supervision - acceptable standards

Grade 12

This course is designed to give a broad coverage of the building construction field. While a practical building project should be part of the course of instruction, emphasis should be placed on the theoretical aspect of the work. This will serve to challenge the ambitious pupil who may be interested in entering the areas of supervision and management.

SAFETY: Instruction in safe practices should be an integral part of this course.

1. Community Planning

Elementary discussion of such topics as: types of construction
for residential, industrial, commercial and church buildings; roads
and services; financing.
A study of the regulations pertaining to municipal developments.

2. Construction Details and Techniques

(a) Layout of site: use of instruments, survey stakes; batter-boards, offset lines, bench marks

(b) Excavations: soil testing, load bearing conditions

(c) Concrete forms: piers, columns, beams, slabs, stairs, openings

(d) Reinforcements and anchors: purpose, placing

(e) Concrete: proportions and aggregates; testing and analysis; pouring methods, curing; principles of pre-stressing

(f) Structural framing

Beams: laminated, steel, concrete; alternate floor supports

Floors: panels, sectionals; provisions for sub-trades

Exterior walls: solid masonry, veneers, panel construction (various kinds), fire blocks, cuts and stops

Interior walls: masonry, metal, composition, sandwich construction, acoustic treatment (various types)

Doors and windows: frames, types, manufacture and setting for both wood and metal

Insulation and ventilation: comparison of various kinds, installation methods, louvres and roof ventilators

Roof construction: mathematical calculation of lengths and sizes of members, calculation of areas and quantities; dormers, cornices, compound roofs; trusses and laminated beam construction; flat and built-up roofing

3. Prefabrication and Packaged Units

(a) Door and window units

(b) Floor and wall sections

(c) Roof trusses and laminated shapes

(d) Kitchen, bath-room and room-divider units

(e) Built-in fixtures and storage cabinets

4. Completion (Millwork)

(a) Trim: members, materials, machining, designs and sizes

(b) Stair-building: terminology, layout; housed and cut stringers; machining and assembling; advanced work on handrails, ballustrades and bullnose treads

(c) Case goods: cabinets and storage facilities

(d) Hardware: locks, overhead and sliding door hardware

5. Allied Topics

A study of the scheduling and installation procedures followed by subcontractors who must comply with local by-laws

(a) Heating and air conditioning: types and installation

(b) Sanitation: plumbing and drainage systems

(c) Electrical: fixtures and convenience outlets

(d) Communications: intercom, telephone and signal systems

(e) Painting and decorating: types and methods

(f) Finished flooring: various kinds of coverings

(g) Exterior completion: walks, driveways, sodding, grading

6. Industrial Safety

(a) General maintenance and proper operation of portable tools and machines

(b) Scaffolds: safe erection procedure

(c) Protective devices: safety apparel; gantrys and safety rails

(d) Safety codes and rules as recommended by the Industrial Accident Prevention Association; safety regulations for various trades

7. Testing and Analysis

A study of the characteristics of various types of building materials and their suitability for specific applications

(a) Wood: technology; cellular construction

(b) Adhesives: relative strengths and qualities

(c) Insulation: comparison of various types

(d) Acoustics: transmission of sound; absorption qualities

(e) Concrete: as outlined in Section 2(e)

(f) Fasteners: nails, bolts, connectors

WOODWORKING - CABINETMAKING AND MILLWORK

Four-Year Programme Grades 10, 11 and 12

Grade 10

The topics listed in Grade 10 Woodworking should be studied to ensure adequate coverage of the subject.

Design, sketching and layout, the interpretation of drawings, the order of operations and bill of material should be emphasized.

SAFETY: Emphasize safe practices in the use of hand and power tools. Stress the use of push sticks, adequate equipment guards and the wearing of proper clothing and safety glasses or masks.

1. Materials
   - (a) Veneers: types and uses, methods of cutting, types of cauls and presses
   - (b) Cabinet hardware: hasps, hinges and catches
   - (c) Plastic laminates: manufacture and uses
2. Production Planning
   - (a) Material estimation: bill of material and cutting list, quality, units of measurement, cost
   - (b) Standardization of parts - assembly line procedure
   - (c) Machine and assembly jigs: value, design and construction
3. Production Procedure
   - (a) Unit construction: material glue-up, sizing, unit assembly
   - (b) Hand tool operations: use of special bits and cutters, use of various types of scrapers, application of plastic laminates, sharpening of scraping tools, application of simple veneers, use of cauls and presses
   - (c) Machine operations: rabbeting, tapering, beveling and chamfering on the jointer; the operation of a stroke sander, the use of pads and lubricants

Grade 11

This course provides a study in full size layout and the projects selected should develop an appreciation of good and creative design. Having used machines and tools previously the pupils should be interested in the development of hand skills and an appreciation of the difference between a machine operator and a skilled craftsman. The course should include an introduction to the history of design.

SAFETY: Safe practices in the use of hand and machine tools should be emphasized.

SPRAY PAINTING

Note: In order to do spray painting proper facilities are necessary for safe and satisfactory operation. If this type of finishing is to be undertaken an approved spray booth installation must be provided.

1. Kitchen Cabinets

   A study of the construction and installation of kitchen cabinets should form an important part of this course.

   (a) Design (custom and production): proportions, drawings, layout rod, facings

   (b) Frames: gables, solid, drum panels, rail; face; undertop and bearing

   (c) Doors: lip, flush, overlay (solid and hollow cored)

   (d) Drawers: lip, flush and overlay; drawer formula; fitting

   (e) Accessories: Lazy Susan, breadboard, chop block, towel rack and sink vents

2. Materials

   (a) Lumber: further study of forest products, defects, characteristics, grades, choice of species

   (b) Veneers: history, manufacturing technology

   (c) Rubbing abrasives: source, uses

   (d) Adhesives: chemistry, extenders, dielectric setting, contact types, mechanical spreaders

   (e) Finishing: standard industrial procedures; comparison and composition of finishing materials; solvents; repairing and refinishing; introduction to spray finishes

   (f) Hardware: further study and classification of specialized hardware, specifications (e.g. standard units of packaging, sizes, etc.).

3. Hand and Machine Operations

   (a) Laying out: scribing to regular and irregular surfaces

   (b) Saws: radial arm, variety and bandsaw, operation and maintenance of each; installation and adjustment of blades; jigs, dado heads, shaper heads and knives

(c) Jointer: jigs and stops: edge and end rabbeting; veneer edge jointing; chamfering, tapering and beveling

(d) Planer: maintenance; planing thin stock, tapering

(e) Shaper: portable and spindle types; maintenance: jigs, pins, collars and guides

(f) Grinder: the composition, shapes and sizes of grinding wheels; grinding hand tools; maintenance of grinders

(g) Sanders: disc, drum, belt and pad types

(h) Lathe: history and development: duplicate, taper and offset turning; fitting ferrules

4. Upholstering (Optional)

(a) Materials: modern and conventional

(b) Tools and machines: types and uses

(c) Fasteners: tacks, thread, cord, staples and other fasteners

(d) Application: various fabrics, materials and fasteners; use of tools and machines

(e) Construction of frames: species and grades of lumber used; joinery and mechanical hardware

Grade 12

SAFETY: Emphasize safe practices in the use of hand tools and machines

The following topics should be appropriately integrated in the course

(a) The Industrial Accident Prevention Association

(b) Native and foreign woods; methods of grading lumber; veneer technology

(c) Layout and design

(d) Contemporary furniture and furniture of the different periods

(e) Production and procedure in industry

1. Materials

(a) An introduction to the botanical classification of trees

(b) An introduction to wood technology: physical structure and properties of wood; density and specific gravity of wood; variations within wood; classification and utilization of wood waste

(c) An intensive study of new products: plastic laminates, fibre board, mouldings, finishing materials, hardware

2. Hand Tool Operations and Construction

   (a) Furniture and fittings: joinery techniques; production and economy in frame construction (gables, undertops and bearing); assembly of frames; sequence of assembly for various types of furniture and fittings

   (b) Drawers: multiple production

   (c) Veneer press: fundamentals of curved plywood form construction; sawing curved plywood form material; assembly of plywood forms; gluing and clamping veneer in a curved form; layout and trimming of plywood curves

   (d) Clamping: clamping of irregular and curved surfaces

   (e) Fitting: scribing furniture, fitting to irregular surfaces, coping mouldings and irregular surfaces

   (f) Fastening and trimming: fastening furniture and fittings to fixed structures; levelling furniture and fittings; hardware choice and installation

   (g) Carving: carving tools and their care, carving simple designs in wood, paring simple curves and bevels

3. Machine Operations

   (a) A study of machine potentialities and limitations; the classification and methods of measuring most woodworking machinery; recent advances in machine construction

   (b) Machine maintenance schedules

   (c) Machine set-up procedure and precautions

   (d) Complex sawing and shaping operations

4. Millwork

   (a) Stair construction: stair layout, stair dimensions (headroom, max. rise and tread sizes), string layout (cut out, housed and open), winder layout, balusters, handrails, shaping irregular mouldings for risers with a radius, veneering laminated risers, newel post construction, handrail fasteners

   (b) Window frames: brick veneer, frame and solid masonry construction; check rail; casement; mullion; sliding sash

   (c) Window sash: check rail, casement and storm (plus vents)

   (e) Door frames: inside and outside

   (f) Roof vents and louvres

5. Conditioning of Equipment (Sharpening)

   (a) Boring bits and drills

   (b) Jointer and planer knives

(c) Router bits

(d) Mortising chisels (hollow)

(e) Carbide tool sharpening

(f) Circular saws: rip, cross-cut, combination and safety; shapes of teeth; swaging, tensioning, setting, jointing and filing blades and cutters

(g) Dado heads and special cutters

(h) Lathe tools (grinding and whetting)

(i) Scrapers: straight and irregular

6. Finishing (Spray and Hand Processes)

Note: In order to do spray finishing proper facilities are necessary for safe and satisfactory operation. If this type of finishing is to be undertaken an approved spray booth installation must be provided.

(a) Preparing a finish for spraying

(b) A study of spray techniques

(c) Cleaning and care of spray equipment

(d) Preparing and applying stain, filler, highlighting materials, rubbing compounds

7. Upholstering (Optional)

After being introduced to upholstering in Grade 11 students should apply their skills toward a project of a more difficult nature.

8. Study and Discussion Topics

(a) Ontario Apprenticeship System

(b) National Employment Service

(c) Workmen's Compensation Act

(d) Labour Relations and Industrial Standards

(e) Factory, Shop and Office Building Act

(f) Hours of Work and Vacation With Pay Act

WOODWORKING - PATTERN AND CASTING PROCESSES

Four-Year Programme Grades 10, 11 and 12

Grade 10

This course is designed to give the student a comprehensive knowledge of the pattern and casting processes.

To accomplish this, pattern projects and facilities for foundry practice should be used.

To ensure adequate coverage of the subject, additional topics should be selected from the Grade 10 Woodworking course outline.

SAFETY: Stress safe practices in the use of hand and power tools.

1. History of Pattern Making and Foundry Practice

2. Study of Materials

   (a) Pattern lumber: pine, mahogany, cherry; characteristics, identification

   (b) Fillets: types, identification

   (c) Pattern coatings: pigments, shellac, lacquer

   (d) Dowels: wood and metal

3. Planning

   (a) Machine allowance: signs and normal pattern allowances

   (b) Draft: normal allowances on general pattern constructions; its application to simple patterns

   (c) Contraction: purpose, allowances for cast metals

   (d) Core prints, core boxes and cores: application of green sand, vertical and horizontal dry sand cores to design

   (e) Colour code

   (f) Simple pattern layout

   (g) Simple template layout

4. Hand Tools

   Pattern making hand tools for cutting, measuring, fastening and assembling; use and care of tools; tool technique and sharpening

5. Machine Operations

   The use of the necessary machines listed under the general Grade 10 Woodworking course

6. Methods of Construction
    - (a) Simple bench pattern construction incorporating green and dry sand cores
    - (b) Turned solid and split patterns with vertical and horizontal core prints
    - (c) Segmental construction for simple patterns
    - (d) Combination of simple lathe and bench work with and without cores
    - (e) Half and full core boxes, core box proportions
7. Foundry Equipment and Materials
    - (a) Composition of moulding and core sands
    - (b) Hand tools: types and uses
    - (c) Moulding flasks: solid and snap
8. Moulding Operations
    - (a) Types of moulds
    - (b) Sand preparation: cutting and tempering
    - (c) Making a two-part mould: with green and dry sand cores; ramming; simple venting, pattern removal, runners, gates, finishing and preparation of mould for pouring
9. Casting Operations
    - (a) Safety precautions
    - (b) Furnace operation
    - (c) Pouring
    - (d) Cleaning castings: shake out and gate removal
    - (e) Checking for visual defects
10. Apprenticeships and Careers in the Pattern Making and Foundry Fields

Grade 11

SAFETY: Safe practices in the use of tools and equipment should be stressed and reviewed periodically.

1. Study of Materials

   (a) Pattern lumber: selection, defects, seasoning and grading

   (b) Special pattern requisites: rapping plates, metal dowels, pattern letters and drawing straps

2. Planning

   (a) Determination of mouldings procedure: parting line, type of core; pattern design for foundry production, number of castings

   (b) Pattern layout: layout board; indication of core, machine and construction allowances

   (c) Pattern draft: determination of draft allowances in relation to the casting design, draft as it affects the machining of castings

3. Hand Tools

   Extension of tool technique; use of core box, planes, bent shank chisels and gouges; use of precision measuring and checking tools such as surface and depth gauges

4. Machine Tools

   (a) Safety rules; lubrication, sharpening, setting and adjusting cutters and blades; use of jigs and holding devices

   (b) Extension of machine tool techniques

   (c) Lathe: face plate turning and rechucking

5. Methods of Construction

   (a) Patterns with horizontal cores, core print allowances for clearance, core box proportions

   (b) Patterns requiring tail prints and core boxes

   (c) Combination of bench and lathe construction

   (d) Simpler type frame and box construction in pattern and core boxes

   (e) Segmental construction: for shell and wheel type patterns

   (f) Stave construction for patterns

6. Foundry Equipment and Materials

   (a) Moulding and core sand mixes for specific metals

   (b) Moulding flasks: three part flasks; use of cheeks and bars

(c) Foundry requisites: gaggers, nails, chaplets, chills and strainers

7. Moulding Operations

(a) Irregular partings: coping out, follow board, sand match

(b) Three part mould

(c) Core making: sand preparation; use of simple dump, frame and parted core boxes; reinforcement; venting; baking; pasting; making of standard stock sizes of cores by machine

8. Pattern and Foundry Technology

(a) Pattern design as related to production: materials and types of patterns

(b) Types of sand moulds: green sand, dry sand and pit

(c) Permanent mould casting

(d) Die casting

(e) Casting defects: causes and remedies, methods of detection, "magnaflux" and X-ray

(f) Dry sand cores: definition and application of suspended, balanced and tail cores

(g) Processing castings: heat treatment for stress relief

Grade 12

SAFETY: Stress safe practices in the use of hand tools and power equipment.

1. Study of Materials

Special pattern materials: plaster of Paris; plastics, wax, metals for metal patterns

2. Planning

(a) Special pattern making such as stop-offs, fillets and loose pieces

(b) Adjustments in design of patterns for machining castings such as addition of lugs and bosses

(c) Storing and recording patterns

(d) Calculation of size and location of gates and runners

(e) Determination of weights of castings from patterns and drawings

3. Hand Tools

Further extension of tool technique as outlined in Grade 11; mention to be made of special metal pattern making hand tools such as scrapers, chisels and height gauges

4. Machine Tools
    - (a) Machine and cutting speeds for lathe and drill press
    - (b) Special cuts and jigs for machine work
    - (c) A study of pattern milling machines and duplicator machines

5. Methods of Construction
    - (a) Box and frame construction: shell types built on forms
    - (b) Patterns and core boxes incorporating loose pieces and means of attaching
    - (c) Patterns and core boxes of built-up construction; further use of segmental construction; wheel construction presenting use of tonque joints; turned core box cavities
    - (d) Formed patterns with irregular parting line; loose flange application with slab core such as offset pipe work
    - (e) Sweeps and templates for plaster of Paris patterns
    - (f) Master patterns: contractions, finish, metal patterns and working patterns
    - (g) Match plates: wood, metal, cast plates; attaching patterns to plates, forming and disposition of gates and runners; layout for one-sided plates, double-sided plates, irregular parting-line plates
    - (h) Repairing wood patterns

6. Foundry Equipment and Materials
    - (a) Special flasks: slip flasks and jackets, match plate, shaped
    - (b) Moulding machines

7. Moulding Operations
    - (a) Making moulds with balanced, suspended and slab cores
    - (b) Moulding with a match plate
    - (c) Making a mould to produce a cast match plate
    - (d) Simple floor moulding

8. Metal Patterns
    - (a) Their place in industry
    - (b) Metals and alloys used for patterns
    - (c) Producing the metal pattern; special allowances
    - (d) Cleaning and finishing metal patterns: methods, tools and machines

(e) Mounting of metal patterns on match plates, cope and drag boards

(f) Repairing metal patterns

9. Plastics, Moulding and Forming

   (a) Their place in modern industry

   (b) Thermosetting and thermoplastic types

   (c) Processes for moulding plastics: compression and transfer moulding

   (d) Laminated plastic construction

   (e) Plastics: use for cores and core boxes

   (f) Repairing with plastics: epoxy resins and their physical properties

10. Pattern and Foundry Technology

   (a) Theory of gating, runners and risers

   (b) Casting design

   (c) Centrifugal and investment castings; lost wax process

   (d) Production planning

   (e) Foundry mechanization and plant layout, types of machines for production

   (f) Metals cast in the foundry

   (g) Carbon dioxide process for cores

RELATED TECHNICAL COURSES

In Grade 11 pupils are required to elect a major Technical Subject in which to specialize. Instruction in the elected Technical Subject is to be supplemented by instruction in related Technical Subjects. The purpose of the related Technical Subjects is to give the pupil a general technical background for his specialized subject and to impress on him the interrelationship of the different trades. The technological content of the subject should be emphasized and the pupil made to realize that the techniques of one trade are dependent on those of another.

Owing to the limited time available for related subjects, standard operations might replace projects as media of instruction. Such operations should be directly applicable to the pupils' major subject and the presentation of instruction should be arranged to include the necessary related information at the time it is required. Close co-operation between the instructors of specialized and related subjects is essential.

Courses of instruction in both major and related subjects should direct the pupils to the use of catalogues and other reference materials for specific information.

ART

Related Instruction for
Pupils Specializing in Printing

Grades 11 and 12

1. Printing History

   The origin and development of letters. Individual projects, such as

   (a) (1) notes and sketches on the origin and development of letters
   (2) study and sketches of classic and modern manuscripts

   (b) construction and illustration of a booklet containing research, sketches, and clippings; applying the principles of cover design, layout, margins, title page, etc.

   (c) creation of classroom display cards on early writing and printing; early printers; historical printing equipment. Making cut-outs of early and modern type faces

2. Lettering

   Types styles: old style, transitional, modern
   Classification and characteristics: Roman, Gothic, Italic, script and text
   Construction: Roman proportion, condensed and extended lettering, single-stroke lettering, representing type faces, selecting and combining types, (Light, medium and bold)

3. Layout

   Use and purpose
   Collection of sample layouts

Units of layout: headings, sub-headings, body matter, rules, ornaments, illustration, colour areas, trade-marks
Construction: a detailed study of the design principles and of the basic forms on which layouts are constructed, balance, proportion, simplicity, beauty, tone, contrast, panels, diagonals, margins

4. Colour

Basic colour principles: hue, value, chroma, complementaries
Gathering and classifying colour areas
Colour theories: Prang, Munsell, Ostwald
Colour in printing papers and inks
Colour schemes: tints, shades, seasonal colours, advancing and receding colours
Gathering samples of colour combinations from printed matter

5. Methods of Reproduction

Study of autographic blocks: lino, woodcuts, wood-engraving, colour blocks
Designing, cutting and printing blocks for school printed matter
Silk-screen methods
Art requirements and limitations of reproduction
A brief study of modern printing methods, particularly the relation to colour illustration and layout
Advertising methods in use to-day

DRAFTING

Related Instruction For
Pupils Specializing in Applied Electricity

Grade 11

This part is to be regarded as a basic unit for all pupils choosing the electrical option (electronics excepted), regardless of any future specialization. The pupil's work may be accepted in the various forms, neat free-hand sketches or instrumental drawings.

The drafting room should contain illustrative equipment sufficient for all the basic symbols introduced and a close co-ordination should exist between studies in this course and those of the major electrical course which the pupil is following.

The course should include

1. Electrical symbols as required
2. Residence circuits from architect's plans
3. Wiring diagram for domestic electric range
4. Control circuits as for furnaces, water heating and refrigeration equipment, farm water supply, etc.
5. Installation and control circuits for D.C. motors and generators including starting and field control rheostats, undervoltage and no field protection
6. Construction of circuit diagrams closely related to the pupil's studies in the major course

Option:

In schools where a department of applied electronics has been established the course in related drafting may vary from the foregoing course and should be designed to correlate more closely with studies in electronics.

Grade 12

The course in electrical drafting for Grade 12 should include

1. Interpretation (blueprint reading) of installation circuits and equipment
2. Construction of drawings involving the basic principles of mechanical drafting as applied to mechanical equipment used in the electrical trade

A selection of work should be made from such topics as

1. Motor and generator winding and connection diagrams
2. Installation equipment, diagrams and specifications
3. Switchboard wiring and mountings
4. Transformer connections and lighting and power circuits
5. Industrial control devices and installations
6. Meter connections and location in circuits
7. Radio circuits and general electronic control devices and installations
8. Development of sine waves for current, voltage and power

DRAFTING

Related Instruction For Pupils Specializing in Auto Mechanics

Grades 11 and 12

1. Blueprint Reading (Mechanical and Electrical)

   Using automotive manuals, charts and suitable current automotive literature, instruction material should be selected which is closely related to the major shop course in mechanics and which will give the pupils training in the following:

   (a) Identification of materials and parts by drawing attention to the symbols employed

   (b) Determination from the drawings of the devices and order of procedure for assembly and dismantling

   (c) Observation of devices and means used to reduce wear, vibration, etc.; to obtain desired linkages and movement control; to obtain desired mechanical security under normal working conditions (locking devices etc.)

   (d) A study of the drafting principles used in a drawing: symbols; selection of views; use of sections, isometric or oblique projections, other projections; materials employed in fabrication; interpretation of exploded views

   (e) Use of catalogues and handbooks showing "outline" or "dimensional" drawings of tools and parts

(f) Simple blueprint reading tests on general orthographic layout

2. Mechanical Drafting

Using automotive parts, (some aeronautical parts may be included), a series of projects should be planned to develop and maintain a working knowledge of the basic principles of mechanical drafting through drawing construction. The pupils' drawings may be accepted in the form of good working sketches in pencil or instrumental drawings

Principles: drawing of cams; principles of gearing as applied to automobiles; transmissions; differentials

3. Electrical Drafting

Using electrical equipment common to the automotive trade, projects should be planned to give instruction in the basic principles of electrical drafting through drawing construction. The pupils' drawings may be accepted in the forms referred to under section 2 above

Principles: interpretation and representation of symbols as required for the projects selected; construction of circuits in sequence of difficulty

DRAFTING

Related Instruction For Pupils Specializing in Building Construction

Grade 11

When practicable, drawing of structure or sections that are to be built in the woodwork shop.

Special emphasis to be placed on layout, specifications, dimensions and notes, sketching.

1. Sections

Details of foundation, sill, cornice, beam construction, interior partitions, bearing and non-bearing partitions

2. Working Drawings of Basement Plan

Showing walls and footings, piers, beams, windows, doors, stairs, chimney, furnace and heating layout, fuel storage, drainage, electrical layout (switches and outlets)

3. Working Drawings of First Floor Plan

Showing walls (exterior and interior); position of joists, windows, doors, stairs, living room, dining room, kitchen, bathroom, bedroom, electrical layout, heating layout, plumbing layout

4. Elevations

Front, rear, right and left views

5. Sections of Building

   Floor levels, grade line, roof pitch

6. Details

   Footings, walls, roof, cornice, chimney, windows, doors, steps, stairs, built-in cabinets

7. Blueprint Reading

   A study of blueprints obtained from the construction field

   Where cabinet-making is taken as part of the course, the related drafting should include projects to give practice in making a bill of material, projection, dimensioning, pattern drawing, cutting diagrams as applied to the cabinet-making trade

Grade 12

Emphasis to be placed on the building code (legal and application forms, permits and fees), sketching, estimating, constructions.

1. Plot Plan

   Street line, sewer and water, excavating

2. Framing Drawings

   Door opening, window opening, arch opening, floor framing plan, roof framing plan, wall frame

3. Standard designs of mouldings and their use

4. Working drawing and full size sections, double hung frame (check rail), casement frame, exterior and interior door frames

5. Drawing and detailing small timber truss (Teco connector), laminated truss

6. A study of blueprints obtained from the construction field

DRAFTING

Related Instruction For
Pupils Specializing in Cabinet-Making and Millwork

Grades 11 and 12

Pictorial and working drawings for various pieces of furniture
Detail drawings for standard parts, drawers, doors, turnings
Full scale layouts, rods, templates for pieces of furniture and also parts
Bills of material
Stock sizes of lumber, how they affect cost and design
Geometric constructions which apply to cabinet-making, regular polygons, ellipses, curved parts

Moulds, the use of scrolls, curves, straight lines and quirks in moulds for above and beneath eye level
The study of wood joints and their relation to design and strength
A study of furniture sizes, table and chair heights, etc.
Simple architectural blueprint reading and a study of detail drawings of built-in furniture, cabinets and similar fixtures
A limited study of
  (a) Historical considerations affecting furniture design

  (b) Furniture styles and periods

DRAFTING

Related Instruction For Pupils Specializing in Machine Shop Practice

Grades 11 and 12

This course should include freehand sketching, sectional layouts of details and assembly, pictorial layout drawing, pipe and structural fabrication, mechanical movement, elementary tool design and the use of handbooks and catalogues.

Projects such as a turnbuckle or some adjusting device involving the use of threads; a machine part in which two or more unlike metals are held together, and must be shown in section; a lubricator, in section, introducing pipe threads
Detail and assembly drawing of a simple mechanical mechanism, involving the use of threads to secure and to adjust, types of fasteners, and use of tolerances and fits, e.g., a milling machine vice, a simple drill jig or fixture
The conventional drawing of a gear; names of gear and tooth parts; development of an involute curve
A series of wheel hubs to show the use of different keys
A ratchet and arm actuated from an eccentric; calculating motion
A fabricated steel part to show the use of welding symbols
The drawing of a small gear box. The use of the handbook for data on gears, cams, shaft and bearing sizes
The meaning of design terms such as factor of safety, stress, strain, centre of gravity, torque, shear, elastic limit
The assembly and detail of a progressive piercing and blanking die, a precision pump, an air drill or a similar tool
Electrical symbols and layouts commonly found on electronic mechanical machines

DRAFTING

Related Instruction For Pupils Specializing in Sheet Metal Practice

Grade 11

Note: The drafting room should be supplied with models and stretch outs.

1. Parallel Line Development

   Two-pieced 45° round pipe elbow, four-pieced 90° round pipe elbow, ordinary tee-pipe (same diameters), inclined branch (same diameters), tee-branch

(branch smaller), eavetrough mitre 90° outside, eavetrough mitre 90° inside, eavetrough mitre other angle, eavetrough outlet, rectangular 90° elbow, flat rectangular 90° elbow, double register box, single register box

2. Radial Line Development

Ordinary funnel with collar, roof jacket with flashing, tapered measure with flaring lip, simple roof ventilator, fruit scoop, tapered pipe flat one side

3. Triangulation Development

Rectangular pitched covers, square to rectangle taper on centre, rectangular reversible, round taper concentric, round taper eccentric, square to round taper, rectangle to round taper off centre, roof chimney saddle, oval to rectangle off centre

4. Blueprint Reading and Estimating

Note: All patterns to be developed in the manner employed in good trade practice.

Grade 12

1. Parallel Line Development

Five-pieced 90° elbow side seam, elbow intersecting round pipe elbow intersecting square pipe, collar intersecting an elbow, inclined branch offset, complete ventilator, offset square pipe, compound offset square pipe

2. Radial Line Development

Round pipe on taper, round pipe tapered elbow, cyclone separator

3. Triangulation Development

Round to ellipse, square to round roof fitting, round to round tapered elbow, square to round tapered elbow, rectangle reversible elbow, unequal Y, two-way bull-head Y, oval to round Y with elbows, two-way Y flat one side, oval to round 90° elbow, double rectangular elbow, three-way Y in line

4. Blueprint Reading and Estimating

ELECTRICITY

Related Instruction For
Pupils Specializing in Auto Mechanics

Grades 11 and 12

A Laboratory Course in Electrical Theory and Testing

1. An experimental review of conductors, non-conductors, simple series and parallel circuits, resistance, current and voltage measurement, Ohm's law, electro-magnetic effects as related to the automotive field

2. Induced Currents

Production of induced currents, including the elementary laws of induction relating to the direction and value of induced pressure with special reference to (1) the automotive ignition coil, (2) magnets, (3) D.C. generator and motor

3. Storage Battery

Construction, theory of operation and behaviour characteristics during charge and discharge; care and maintenance with special precautions in handling

4. D.C. Generator and Motor

Construction, theory of operation and characteristics of automotive generators and starting motors and laboratory methods of locating faults; study of characteristics of fan and other auxiliary motors

5. Condensers

A study of the function of capacity in circuits with special reference to the condenser across the breaker points

6. Auxiliary Automotive Electrical Apparatus

Study of construction and theory of operation of electrical gauges, meters, heat indicators, etc.

7. Voltage and Current Regulators

Construction, purpose and theory of operation; laboratory adjustments and methods of by-passing

8. Optional

Short laboratory course in radio mechanics leading to principles involved in radio installation and minor repairs

Electronic control of automotive equipment such as headlights and doors

MACHINE SHOP PRACTICE

Related Instruction For
Pupils Specializing in Auto Mechanics

Grades 11 and 12

Topics should be introduced as required and as the course progresses. Teachers should plan activities in order to make certain that the pupils have a good working knowledge of the following topics: lubrication of machines; cutting lubricants; cutting speeds; thread forms and standards; lead and pitch of screws; letter and number sizes of drills; tap drills; tolerances; marking materials—blue vitriol, prussian blue, soapstone, chalks, etc.; metals—nature and use of irons, steels, brasses, babbitt, alloys; S.A.E. markings of steels; spark test of metals at the grinder; construction and use of hand tools—files, stock and dies, hacksaws and similar tools.

GRADE 11

Standard Operations

1. Benchwork: use of layout tools; characteristics and uses of hand tools, as file, hack-saw, etc.
2. Lathe: aligning lathe centres; mounting and turning work on an arbour; setting up work in four-jaw independent chuck; squaring a shoulder; parallel turning using micrometers; cutting external threads
3. Drill Press: drilling speeds and feeds for carbon and high-speed drills; drilling jigs and set-ups; drilling to an accurate layout
4. Milling Machine: simple indexing for polygon shapes and spur gear teeth
5. Grinder: sharpening tools such as chisels, scribers, centre punches; adjusting work rest, hood and observing safety practices

Grade 12

1. Benchwork: filing parts to a size and/or to a fit; scraping bearings or flat surfaces; the use of gauges such as screw pitch, thickness, depth, centre; measuring with the vernier caliper and the inside micrometers
2. Layout Operations: using layout equipment--parallel bars, combination set, Vee blocks, hook rule, test dial indicator
3. Heat Treating; hardening and tempering steels; annealing copper tubing
4. Lathe: advanced operations such as turning and fitting a taper to a gauge; drilling, boring and reaming in the lathe
5. Drill Press: more advanced operations involving drilling set-ups and the use of jigs and fixtures
6. Milling Machine: operations to involve special feeds and set-ups such as side milling, cutting keyseats, etc.
7. Grinder: the surface, tool and cutter and cylindrical grinders; purpose of each; names of operative parts; safety precautions; setting up work; selection of grinding wheels; truing wheels; some simple grinding operations

MACHINE SHOP PRACTICE

Related Instruction For
Pupils Specializing in Electricity

Grade 11

Operations

1. Bench: layout tools; the selection and proper use of the hand tools common to the electrical trade such as files, chisels, taps and dies, size of tap drills for various metals, the hand hack-saw, the electric hand drill

2. Lathe: parallel and taper turning; using compound rest and steady rest; selecting feeds for turning and thread cutting; cutting and chasing threads; turning soft metals such as copper

3. Grinder (pedestal): sharpening twist drills, chisels, lathe tools

Grade 12

1. Bench: improvement in technique and accuracy in benchwork; filing, scraping and fitting bearings or mating parts

2. Lathe: taper turning using the taper attachment; finish turning in brass or bronze; turning running and press fits; drilling, boring and reaming; special screw cutting; truing shafts

3. Grinder (pedestal): sharpening star drill, rawl drill, masonry drill, carbide-tipped drill, taps

4. Milling Machine: milling a flat on a shaft; cutting a keyway

5. Technological information: types of bearings; checking shafts with dial indicator, types and uses of machine keys; classes of machine fits; tolerances and limits, lubricants; ferrous and non-ferrous metals; hardening and tempering steel

MACHINE SHOP PRACTICE

Related Instruction For Pupils Specializing in Mechanical Drafting

Grade 11

Operations

1. Bench: use of layout instruments, bench hand tools; working to layout lines or to gauges

2. Drill Press: the use of jigs and fixtures in drilling flat and cylindrical work in various metals

3. Lathe: use of three and four jaw chucks; special turning operations; drilling, boring and reaming, tapping--using the three-jaw chuck; screw-thread cutting

4. Shaper: vertical and angular shaping; use of clamps for special set-ups

5. Milling Machine: slab milling--horizontal surfaces, external and internal surfaces, with side or face cutter; milling rectangular or hexagonal shaped pieces; straddle milling

Grade 12

Operations

1. Bench: layout, using the surface plate; more difficult filing operations to closer standards of accuracy on contour work

2. Drill Press: drilling to a layout, drawing centres; reaming; boring; tapping; use of jigs

3. Lathe: turning to close limits; use of the dial indicator; cutting external and internal threads; use of the taper attachment

4. Milling Machine: milling a keyway, grooving, gear cutting, using the vertical milling head

5. Metallurgy, the theory and practice of: terminology; hardness standards; S.A.E. ratings; metal alloys

MACHINE SHOP PRACTICE

Related Instruction For
Pupils Specializing in Pattern and Casting Processes

Grade 11

1. Technological information: composition and characteristics of metals and alloys used in castings and metal patternmaking; melting points of metals; normalizing and annealing; hardness testing; the effect of blow holes, cold shot, shrinkage, cracks in castings

2. Benchwork: the use of layout tools and materials; layout, filing, drilling, tapping on different metals; file and scrape a split metal pattern and insert dowel pins; layout of a simple casting involving different machine operations to check machine allowance, shrinkage and work

3. Machine Work: simple operations on the lathe, shaper, drill press and milling machine. These operations should cover a study of feeds, speeds, cutting tools and depth of cut; machining cored holes, advantages and disadvantages of coring a hole, effect of too little metal for machining and hard castings; coolants for metal cutting; machine lubrication; safety precautions

4. Special Machines: the gap lathe for large diameters; the pedestal grinder--grits, grades and bond of grinding wheels

5. Heating Operations: sweating pattern halves together for machining; hardening tool steel

Grade 12

1. Metallurgy: heat recording devices--the thermocouple and pyrometer; seger cones; study of different grades of cast iron after machining to show the granular structure and its corresponding physical characteristics; observation and discussion of parts of machine tools and the reasons for the selection of the materials used in construction; seasoning of castings to overcome warp and wind; methods employed; chilled surfaces on castings, uses, procedure; use of handbooks to determine the physical properties of metals

2. Machine Parts: an examination of some common machine parts to study their nomenclature, location and function--base, bracket, boss, apron, rocker arm, bearing cap, braces, bushing, cam, counterweight, cover plate collar, cylinder, eccentric, flange, gib, housing, link, lug, quadrant, quill, rail, saddle, tongue piece; the

use of the following as an aid to casting or machining--fitting strips, fillet, ribs, boss, hub, spigot, cast-slotted holes, taper and parallel gibs, good grade metal for surface subject to wear

3. Benchwork: uses of more advanced layout tools; layout and methods of attaching patterns on metal plates; checking castings for size and defects preparatory to layout; bridges used in cored holes as assists in machining; repair methods to remedy casting defects--plugs, brazing, welding

4. Machine Operations: sequence of operations in machining a casting which requires a variety of machine operations; aids required in castings to facilitate machining --lugs, bosses, etc.; proper draft in cored holes to obviate excessive machining; difficulties encountered where cored hole has shifted or is out of proper alignment; clamping to avoid stresses or distortion; securing work in faceplates, chucks, vises, angle-plates, jigs or fixtures; machining allowances; trimming metal patterns--uses of portable grinder

PATTERN AND CASTING PROCESSES

Related Instruction For
Pupils Specializing in Mechanical Drafting or
Machine Shop Practice

Grades 11 and 12

Note: Suitable projects or operations on projects should be selected to give pupils the practical applications of the course.

1. The purpose of patterns and the interrelationship of patternmaking, foundry and machine shop operations. What the machine designer should know about these operations.

2. The historical background of patternmaking

3. Planning: sketching and full sized layout; special machining allowances for different metals; the theory of contraction and shrinkage in castings; the shrink rules; draft allowances in relation to casting design and the effect in the machining of castings

4. Pattern materials: qualities--white pine, mahogany, walnut, cherry, metal, plaster of paris, clay; uses and applications

5. Types of patterns: one piece; two-part; split; turned; segmental

6. Fillets: purpose; types

7. Pattern finishing (shellac) and identification

8. Assembly of parts: gluing and nailing, the use of dowel pins in split patterns

9. Core prints and core boxes

10. Branches of moulding: green sand; dry sand; loam; metal

11. Gating moulds: purpose of gates in moulds; types of gates for various metals; skewing gates and risers; pouring basin

12. Metal patterns: the need for and use of these; how they differ from regular patterns; metals and alloys used in patterns

13. Die castings: comparison of die and sand castings; advantages and disadvantages, typical articles which may be die cast; alloys used in the casting

14. Power tools: special uses and operations on power tools such as lathe and disc sander which are peculiar to patternmaking

SHEET METAL

Related Instruction For
Pupils Specializing in Air Conditioning and Refrigeration

Grade 11

SAFETY: Safety is essential and the use, care and maintenance of all tools and equipment should be stressed.

1. Sheet Metal Problems

   (a) Linear, angular, surface and capacity measurements

   (b) Estimating material costs

2. Pattern Development

   (a) Parallel line method: three and four piece round elbows; square elbows; ordinary tees and Y branches; register boxes; chimney cap or ventilator head; flashings

   (b) Triangulation method: principles of triangulation; forge and exhaust hoods; rectangular to round fittings (symmetrical and non-symmetrical); square to square transitions; rectangular reversibles; reducers and furnace boots

   (c) Radial line method: funnels, regular and flat on one side; flaring pan and pitched covers; tapering pails and measures; reducers

3. Duct Construction

   Low velocity systems: blueprint symbols for ventilating and air conditioning systems; gauges and types of metals and material; cross and longitudinal seams; hangers and supports; elbows, tapers and offsets; streamliner branches and tee connections

4. Seams and Seaming Allowances

   Seams: standing, double, grooved, Pittsburgh lock, riveted, lined and reinforced seams; amount of material required for each; common uses and advantages of each in fabrication and installation

5. Machine Processes

   (a) Easy edger: turning edges on flat patterns

   (b) Elbow edging machine: forming edges for round elbows

   (c) Unishear, ring and circle shear: cutting patterns

   (d) Bar and tube bender: setting up and forming wire, rod and bar stock

   (e) Spotwelder: setting up and changing tips for various jobs; controls and their functions; care and safety precautions

(f) Power machines: it is desirable that students obtain some familiarity with power-operated equipment

Grade 12

SAFETY: Safety is essential and the use, care and maintenance of all tools and equipment should be stressed.

1. Pattern Development

   (a) Parallel line method: intersections on irregular surfaces, elbows and branches, round and rectangular pipe and duct fittings, louvres

   (b) Radial line method: round and rectangular eccentric shapes, stack heads and tapered elbows

   (c) Triangulation: eccentric transition fittings, symmetrical and non-symmetrical Y branches from round pipes of equal and unequal diameters, rectangular Y branches with different areas for ventilation systems; regular and compound offsets; transition elbows

2. Duct Construction

   Dampers, access doors and firedoors; louvres and screens; exhaust hoods and fume hoods; goosenecks; belt guards; flexible connections and acoustical treatment; casings and housings

3. Seams and Joints

   Blower and ventilation systems: all the seams and joints involved in the fabrication and assembly of ducts and pipes such as riveted, hammered lock, drive cleat, "S" cleat, standing and slip lock seams

4. Hollow Metal Work

   Blueprint reading; metal thicknesses; bend allowances, sharp angle bends, radius bends; forming procedures; methods of joining and seaming, spot welding, riveting, arc and acetylene welding

5. Machine Operations

   (a) Rotary machines: wider use of the elbow edging and turning machines in the fabrication of pipe and duct fittings; adjusting heads for end-play, correct position for various gauges of metal used

   (b) Pittsburgh lockformer: adjusting for various gauges; special attachments

6. Sheet Metal Problems

   Stretch-out lengths for elbows, offsets and pipe lengths; calculating diameters, lengths and areas for transition and Y fittings; estimating labour costs

7. Oxy-Acetylene Welding (Optional)

   Note: Welding should be taken in the welding shop if one is available.

   History of oxy-acetylene welding; safety precautions; glossary of terms, welding and cutting; care and use of equipment (tanks, gauges, torch tips and valves); setting up and turning off equipment; pressures, tip sizes and material thicknesses; chemistry of flame (neutral flame, oxidizing flame, carbonizing flame); corner weld, butt weld, lap weld and fillet weld; welding and brazing light sheet steel and small structural shapes

8. Oxy-Acetylene Cutting (Optional)

Principles of oxy-acetylene cutting, setting up equipment, pressures, cutting tips; to cut a given straight line free-hand and using a guide bar; to cut a circular hole in light gauge metal

SMALL ENGINES

Related Instruction For Pupils Specializing in Auto Mechanics

Grade 11

Refer also to the courses in Small Engines in the Two-Year Programme.

SAFETY

(a) The safety precautions specified in the manufacturer's manual regarding the driving mechanisms and the driven units

(b) The necessary precautions to prevent accidental starting

(c) Safe practices in regard to toxic and explosive fumes and in the use of tools and equipment

1. The Internal Combustion Engine

    (a) A review of the two and four stroke cycle of engine operation

    (b) The types and parts of small engines and the functions of the parts

    (c) Construction details such as light weight, materials, valve types, cylinder design and governor mechanisms

    (d) A study of engine designs such as single and multi-cylinder two and four stroke cycle engines with horizontal and vertical shafts

    (e) Typical engine applications such as lawnmowers, outboard motors, chainsaws, portable pumps and portable generator units

2. Lubrication

A review of the lubrication of four-stroke cycle engines; the lubrication of two-stroke cycle engines including the mixing of gasoline with the proper type and grade of oil and in the correct proportions

3. Cooling

    (a) A study of the air cooling system

    (b) Maintenance of cooling systems

4. Fuels and Fuel Systems

   (a) Inspection and testing of fuel pumps

   (b) Examination and service of fuel filters

   (c) Pressurized tank construction

5. Carburetion and Fuel Induction

   (a) Small engine carburetors - assembly and installation

   (b) Carburetion troubles

   (c) Gasoline deterioration and effects of lead in fuels

   (d) Two stroke cycle induction and crankcase compression

6. Ignition

   (a) A review of the fundamentals of electricity and magnetism

   (b) Electro-magnetic induction

   (c) Construction and operation of the magneto

   (d) The selecting, testing and servicing of spark plugs

   (e) Wiring of the ignition circuit

7. Alternators and Rectifiers

   The principles, types and operation of alternators and rectifiers; installation and service

8. Starting Mechanisms

   The principle, assembly and installation of electric and manual types

9. Engine Operation

   Safety checks before starting; carburetor adjustment; testing brake horsepower using fluid, electric or Prony brake methods

10. Service Work

   Operation and repair of related units such as lower transmission units, electric shifts, clutches, couplings and controls; practical work should be performed on different types of small engine powered machines

WELDING

Related Instructions for Pupils Specializing in
Aircraft Mechanics, Auto Mechanics, Machine Shop Practice,
Sheet Metal Practice and Plumbing

Note: The emphasis of the course for pupils specializing in Mechanical Drafting should be to teach these pupils how welding techniques and practices can be used in machine design.

Acetylene Welding
Grade 11

Note: Suitable projects or operations on projects shall be selected to give pupils the practical applications of the course.

General instructions on the purpose of the course, the care of the equipment, safety precautions, the use of instruction sheets, work assignments.

1. History and principles of oxy-acetylene welding and cutting; first commercial torch; method of producing calcium carbide; discovery of oxygen

2. Scope of oxy-acetylene process, growth of industry, different processes

3. Auxiliary equipment and supplies: torches; glasses; cutting machine; filler rods (Hercules, cast iron, bronze, etc.); squares; clamps; pliers; etc.

4. Using the equipment: connecting the apparatus; care of cylinder valves; assembling hose lines regulators and blowpipes; shutting down the equipment; closing the blowpipe needle valve; releasing gas from lines and regulators; table of gas pressure

5. Care of regulators: need for releasing adjusting screws; tightening of regulator nuts; fibre washers

6. Types of flames and their temperatures: carburizing; neutral; oxidizing; their approximate temperatures

7. The different flames in welding: carburizing; neutral; oxidizing (drawings of each)

8. The principles of good welding: fusion; bronze welding; brazing; ratio of gases

9. The velocities of flame: increase of each gas to change velocity of flame; need for changing tip size when maximum output of gas is reached

10. Explosive gas mixtures: flashback; backfire; safety precautions; causes

11. Characteristics of beads: penetration and fusion; proper alignment; appearance

12. The materials used and procedure in running beads without filler metal

13. Selection of welding rod and fluxes: proper selection; ferrous rods; non-ferrous rods; fluxes

14. Importance of oxygen gas: combustion; properties; manufacture; pressure; care of cylinders

15. Acetylene gas: manufacture; properties; construction of cylinders

16. How to test welds: purpose; method; results; method of finding per cent of elongation

17. To butt weld on sheet steel: material; preparation of plates; procedure; results; test

18. Theory of cutting steel: principles involved; formation of oxides; table of gas pressures

19. Types of fillet welds: definition; types; convex welds; concave welds; proper leg length

20. How to run beads without and with filler metal, make a corner weld without and with rod, butt weld on sheet metal, hand-cut straight line cuts, lap weld on steel plates. Testing the above welds

Grade 12

1. Construction of acetylene torches; purpose of the torch; mixing chamber; types of torches

2. Construction of acetylene cutting torches; purpose; type of metals that can be cut; types of torches; oxygen-lance type; powder cutting

3. Construction of regulators: working parts, working mechanism, types of regulators, safety

4. Reconditioning tips: method of straightening tips: cleaning plugged orifices; drilling of orifices

5. Guided-bend test: appearance of welded specimens; precautions against slag; procedure for cutting plates; method of bending samples; results

6. Welding and cutting on containers, tanks and vessels; rules to be adhered to before welding; method of cleaning; precautions to be taken during welding

7. Multiple welds—pass welding, on groove welds; lap welds; tee welds in flat, vertical overhead positions

8. Principles of joint design: butt welds; lap joints; tee joints; corner joints; edge joints

9. Types of steel: low, medium, high; effects during welding

10. How to circle cut and pierce holes, make a fillet tee weld, butt weld a vee groove, make multiple pass lap and tee welds, run a bead of bronze filler on mild steel, braze weld a butt joint, braze weld cast iron, run vertical beads. Testing the above welds

Electric Welding
Grade 11

1. General instructions: care of equipment; safety precautions in using machines; the operation of machines on high voltage, prevention of fires; safety precautions for the operator

2. To set up A.C. and D.C. units: main supply equipment; ground cable; voltage control; amperage control; polarity of switch

3. History and scope of welding: discovery of electric arc in the first part of the 19th century; important part played by welding during World War II; present-day welding procedures

4. Proper technique for striking an arc: tapping method; scratching method; arc length; crater; characteristics of beads

5. Definitions of carbon arc welding, metallic arc welding, inert gas welding, inert spot welding, automatic inert gas welding

6. Technique of arc welding: unshielded arc; shielded arc; arc length; penetration due to speed of travel and current setting

7. Joining of beads: the importance of filling in the crater; the proper procedure of striking the arc; running beads in the opposite direction

8. Elementary electricity: comparison of D.C. current to a water system; A.C. current

9. Weaving of electrodes: types, use, limitations, angles, heat control

10. Elementary classification of electrodes: color band; type and current setting; where used; characteristics

11. Study of penetration, fusion, undercut, overlap, reinforcement

12. Construction of hand-cutting torches: plan, types, lance, powder

13. The technique of making fillet welds: preparation of plates

14. How to run stringer beads, join stringer beads, run beads using a weaving technique, run an edge weld on steel plate, hand-cut straight line cuts, make a fillet lap weld. Tests on the above welds

Grade 12

1. Theory of arc welding; how arc is formed; reason for light and dark flashes during welding; ionization of coated electrodes

2. Study of beading and building up; padding of worn surfaces; shaft-building

3. Comparison between bare rod and coated electrode: oxidation; lightly coated electrodes; functions of heavy coatings

4. The study of multiple-pass beads on groove welds, lap welds, tee welds in flat, vertical and overhead position

5. Classification of electrodes; A.W.S. numbering system

6. Principles of joint: butt joints, lap joints, tee joints, corner joints, edge joints

7. The proper technique for preparing and testing plates for root-bend and the root-face testing operation

8. Welding and cutting on container tanks and vessels, method of cleaning, precautions

9. How to weld in horizontal position: angle of electrodes; current used; speed of travel; overlap precautions

10. Types of steel: low, medium and high carbon; effects during welding and after welding; elimination of cracking

11. Effects of common elements on weldability of steel: manganese; nickel; sulphur; phosphorus

12. Advanced electricity: A.C. transformers; selenium rectifiers

13. How to make a fillet tee weld; pad a mild steel plate; pad a mild steel shaft; make a multiple pass weld on a lap and tee joint; weld a single V butt joint; preparation on mild steel using a backing strip; run beads in horizontal position; make a horizontal lap weld; make a horizontal butt joint with and without backing strip. Testing the above joints

SCIENCE, TECHNOLOGY, AND TRADES BRANCH

Five-Year Programme

The Five-Year Programme in this Branch leads to a Secondary School Honour Graduation Diploma. This programme as well as leading to Grade 13 standing provides pupils with an opportunity to study Technical Subjects and obtain technical knowledge and skill as a background for future education or as an aid to employment.

Facility in communicating ideas clearly and concisely either orally, graphically or in the written form should be an objective of all programmes of the Science, Technology and Trades Branch.

In all Technical Subjects emphasis should be placed on accurate measurement, together with the function, basic principle and proper use of various instruments and the interpretation of the data obtained. The plotting of the information and the interpretation of graphs should be an integral part of these courses.

Report writing should be part of the work in all Technical Subjects. The writing of reports on experimental work and the preparation of essays on technical topics train the pupil in accurate observation and clarity of expression and broaden his knowledge through the use of reference materials.

Generally in Grades 9 and 10 the pupils will receive instruction in several Technical Subjects. In Grade 11 the pupil is required to select two Technical Subjects from the list below. One of these is considered a major subject and is continued into Grade 12; the other, a related subject, is completed in Grade 11. In Grade 12 he is required to select a second related subject.

Note: Course outlines have not been included for Grades 9 and 10 of the Technical Subjects. Teachers are referred to the course outlines for these grades in the Four-Year Programme and are expected to make suitable adaptations of such courses keeping in mind the time available and the technological nature of the courses in the Five-Year Programme.

Course outlines are included for Grades 11 and 12 of the Technical Subjects which may be included in this programme.

Major and related Technical Subjects are to be chosen from the following list:

Drafting, Architectural
Drafting, Mechanical
Electricity
Electronics
Industrial Chemistry
Industrial Physics
Machine Shop

Note 1: The courses offered shall be technological in nature. Where possible problems should be introduced that require numerical calculations.

Note 2: With the prior approval of the Minister, alternative Technical Subjects may be taken in schools unable to offer one or more of the Technical Subjects listed above.

ARCHITECTURAL DRAFTING

Five-Year Programme Grades 11 and 12

Grade 11

1. Building Construction Details

    (a) Preparation of working details involving the following elements singly or in combination

    Foundations: soil conditions; slab, stepped, offset, plain and reinforced footings; post, pier, column and wall foundations; foundation waterproofing

    Frame wall construction: elements of balloon and braced frames; wood coverings

    Masonry wall construction: wall thickness; face and backing units

    Wood floor construction: joint arrangement, fire-stops, bridging, girders, trimming, floors

    Carpentry and joinery: joints, rough and finished carpentry, trim details

    Windows: double-hung, casements in wood and metal; mullions, caulking; types for wood and masonry walls

    Doors: construction, exterior and interior types and sizes, hardware

    Fireplaces: hearth, throat and flue construction; surround and mantel

    Chimneys: flue types and sizes; wall sizes and materials; cleanouts

    Stairs: types; open-and closed-string construction; tread, riser and hand-rail relation

    Wood roof framing: wood truss construction; elements of the flat, lean-to, hip, gable, gambrel, mansard types; dormers, coverings, cornices

    Flashings: for hips, valleys, chimneys, cornices, parapets, soil pipes

    (b) Layouts and working drawings: incorporation of the foregoing details in the working drawings for a kitchen equipment layout, summer cottage or similar project

    (c) Some brief exercise in inking should be given

2. Building Materials and Methods

    An elementary study of the materials of building construction and the local building by-laws and practices. This study should be carried on concurrently with the preparation of the details outlined in 1 above.

    (a) Wood: drying, shrinkage, defects, sawing, grading, measurement; properties and uses of various building woods

    (b) Lime: properties; crushed and hydrated; mortar, plaster

(c) Portland cement: properties, uses in mortar, stucco, concrete

(d) Brick: varieties, uses, types of bonds, joints, mortar

(e) Stone: classifications, properties and uses of granite, limestone, sandstone, marble, slate and shale; properties and application of rubble, ashlar, veneers; bonding and waterproofing

(f) Concrete: proportions, mixing, placing, curing, forms, uses of steel reinforcing, pre-stressing

(g) Gypsum products: properties of gypsum; use in plasters, boards, blocks, slabs; dry wall construction

(h) Masonry units: concrete, cinder-concrete, silica, clay blocks

(i) Flooring: wood, concrete, terrazzo, mastic, tile, linoleum, cork, rubber coverings

(j) Glass: varieties, commercial standards; structural glass and block

(k) Paint: composition and uses of paints, enamels, varnishes, stains; paints for wood, metal, plaster, concrete

(l) Metals: properties and uses of iron, steel, copper, lead, zinc, tin

(m) Insulation: types, application and vapour barrier

3. History of Architecture and Design

(a) General outline of the history of ancient building with emphasis on the Greek and Roman periods, particular attention being given to the use of materials, methods of construction and to the form and proportion of details of these periods which are still in use

(b) Freehand sketches or formal drawings of representative details of the various periods

Grade 12

1. Working Drawings

(a) Residence plans: preparation of working drawings of a small residence at a scale of ¼" = 1' - 0", complete with details such as wall sections, windows, main entrance doorway, porches, cornice, bay windows, dormers, kitchen cupboards, staircase, mantel and interior trim

(b) Some exercise in inking

(c) Mechanical equipment layouts: piping diagrams for hot water heating and water-supply systems; duct layout for the heating and ventilating of a small building

(d) Structural steel details: working details using standard shapes for steel-framed bay or similar project

(e) Surveys: drawing of a land plot from notes prepared in the field showing buildings, natural features, levels, linear and angular measurements; measurement of building details

2. Building Materials and Methods

The work of Grade 11 extended to include:

(a) Running lines and staking out

(b) Organization of work and sequence of trades

(c) A study of plumbing installations including materials and construction of drains, soil pipe, wastes, vents, traps, fixtures, septic tanks, hot and cold water supply, gas piping

(d) Heating installations: comparison of warm-air and hot-water systems, gravity and forced circulation; gravity or forced air conditioning, radiant heating; boilers, radiators, pipe and fittings, controls; elements of air conditioning; fuels; calculations for heat loss, radiation, duct work; insulation types, points of application

(e) Electrical work, service entry, switches, distribution, circuit arrangements, armoured cable, non-metallic cable and rigid conduit installations

(f) The study and preparation of specifications for a small residence covering excavation, masonry, rough and finished carpentry, lathing and plastering, sheet metal and roofing, tile work, painting and glazing, plumbing, heating and electrical work

3. Structural Design

The objectives of this course are to teach good engineering procedure and to familiarize the students with present day structural design methods

(a) Strength of materials: definition of strength of materials; use of strength of materials in structural design

(b) Forces: compression, tension, shear, elements of a force, vectors

(c) Stresses: mechanical properties of materials, strength, stiffness, elasticity, ductility, malleability, deformation, elastic limit, yield point and ultimate strength, modulus of elasticity, factor of safety, allowable unit stresses

(d) Equilibrium: definition, parallelogram of forces, resultants, equilibrant

(e) Beam Design:

Types of loads: point load and uniformly distributed load; conditions for equilibrium; principle of moments

Reactions: calculation of R1 and R2, simple beams, cantilever beams

Vertical shear, calculations - diagram

Bending moment, calculations - diagram

Internal resistance - resisting moment, horizontal shear (for timber only)

Flexure Formulae. Determination of section modulus. Selection of beam - timber, steel

Deflection: definition, maximum deflection for a beam with a concentrated or point load at the centre; maximum deflection for a beam with a uniformly distributed load, formulae for beam deflection

Simple problems in beam design in steel and timber

(f) Properties of sections: centroids, moment of inertia, moment of inertia for rectangles, circles and triangles, section modulus

(g) Design of beams and lintels: steel sections, timber sections, types of lintels

(h) Column design: short columns, long columns; end conditions; least radius of gyration; slenderness ratio; column formulae pertaining to steel columns, A.I.S.C. and C.I.S.C. Codes, local municipal by-laws; timber columns

(i) Timber construction: design of various structural members in timber such as floor joists, girders, ceiling joists, built-up sections, columns and rafters; uses of laminated wood

(j) Steel construction: design of steel beams and columns; use of open-web steel joists and long-span steel joists

(k) Reinforced concrete: design of a simple reinforced concrete beam, floor slabs, methods of reinforcing

MECHANICAL DRAFTING

Five-Year Programme Grades 11 and 12

Grade 11

Note: All work to be done according to C.S.A. Standards.

1. Detail and Assembly Drawings

   (a) Machine fastenings; selection of and correct specifications for machine screws, studs, bolts, nuts, washers, taper pins, cotter pins, retaining rings and other fasteners

   (b) Keys and key-seats

   (c) Threads: National, Unified, Whitworth, Acme and Square; corase, fine and extra fine threads, multiple threads, right and left hand threads, pipe threads; thread terminology

   (d) Machine fits, tolerance, C.S.A. standards

   (e) Further sectioning; introducing broken-out, offset and phantom sections; an assembly in section

   (f) Drawing of machine parts from notes and sketches obtained by measuring actual objects

   (g) Selection and use of common metals and materials

   (h) Specifying and listing detailed and stock parts on the drawing and in the bill of material

   (i) Pencil drawing on transparent paper, inking and reproduction (Inking should be touched on only briefly.)

   (j) Use of lettering devices

   (k) Dimensioning: introduction to the complete decimal and metric systems of dimensioning

2. Surface Finish

   Specifying the surface quality for appearance and application using C.S.A. symbols for surface roughness, waviness and lay

3. Geometrical Construction

   Geometrical construction for tangential, elliptical, involute and cycloidal curves

4. Weights of Materials

   Calculation of the weights of castings, structural steel, stock and machined parts and other materials

5. Gearing

   The greater part of the time for this topic should be spent on fundamentals of gearing, uses of various gears and formulae. Spur gears: tooth parts; plotting tooth curves by the base circle method; drafting problems involving details of pinions and spur gears; working drawings of spur gears using conventional symbols and data block instead of tooth shapes

6. Pictorial Drawing and Sketching

The continuation of pictorial drawing as taught in Grade 10. Emphasis to be placed on pictorial sketching. Perspective drawing and sketching may be included if time permits

7. Auxiliary Views

More advanced problems on auxiliary views; introduction of secondary auxiliary views and revolutions

8. Development of Surfaces

Triangulation method of development for objects such as transition pieces and irregular conical shapes

9. Blueprint Reading

Grade 12

Note: All work to be done according to C.S.A. Standards.

1. Machine Drawing and Design

   (a) Gathering data from catalogues, hand-books and reference books

   (b) Shafts and couplings: flange couplings, shaft collars, fluted and splined shafts, universal joints, flexible couplings. Drawing time should be limited

   (c) Bearings: friction and anti-friction; use of manufacturers' hand-books

   (d) Sketching machine parts to determine approximate dimensions; making layout in pencil

   (e) Selection of materials - S.A.E. and A.I.S.I. steels, various metals, plastics and other materials

2. Gearing and Actuators

   (a) Gearing problems: use of formulae and prepared tables of gear data for advanced problems in spur and bevel gears, worm gears

   (b) Drafting problems in the layout of devices producing mechanical movements by means of linkages, cams and electrical, hydraulic and pneumatic actuators

3. Strength of Materials

Design problems involving elements of strength of materials; simple tension, compression, torsion, bearing, direct shear and bending or deflection; unit stress, unit strain, ultimate stress, elastic limit, safe working stress, factors of safety, use of hand-books to determine physical properties of materials

4. New Materials, Processes and Techniques

Pupils should become familiar with any new industrial processes or techniques as the process or technique becomes accepted. Such information might concern powder metallurgy, high temperature resistant alloys, materials with a low coefficient of friction, electric discharge machining, explosive metal forming, new metals, plastics and other materials

ELECTRICITY

Five-Year Programme Grades 11 and 12

Grade 11

SAFETY: Safe practices should be stressed.

Problems on the topics studied should be assigned in a systematic manner to clarify and drill the principles involved.

1. Electro-magnetism

   (a) The magnetic circuit; the relationships between the magnetomotive force, flux and reluctance; flux density; formulae; C.S.G. or M.K.S. system of magnetic units

   (b) A study of the magnetizing curves for cast iron and commercial grades of core materials

   (c) Series magnetic circuits involving various materials and air gaps; problems

2. Insulation

   Properties of insulating materials such as rubber, varnishes, plastic compounds, impregnated paper, varnished cloth, tapes, asbestos and silk

3. Resistor and Resistance Measurements

   (a) Measuring the resistance of resistors connected in series and in parallel and combinations of both; methods and formulae for determining the combined resistance; problems

   (b) Electrical conductance; problems

   (c) Kirchhoff's Laws - the solution of network circuits using Kirchhoff's Laws

4. Electrical Measurements

   Note: The proper use and care of instruments should be stressed.

   (a) The D'Arsonval Galvanometer: parts, principle of operation and its application in the voltmeter, ammeter and ohmmeter

   (b) Bridge Circuits: the Wheatstone Bridge, the slide wire bridge

   (c) Power Measurement: the construction and principle of operation of a wattmeter; proper wattmeter connections; measurement of power

5. D.C. Generators

   (a) The direction and magnitude of the emfs induced in conductors cutting a magnetic field; formulae, problems

   (b) D.C. Generators: parts and their functions; types and connections; self and separate excitation; factors affecting generated voltage; the building up of a shunt generator; commutation; armature reaction and commulating poles

(c) Generator characteristics: the saturation curve; the load or external characteristics of shunt and compound generators; regulation; losses in D.C. generators; efficiency

(d) Generator applications

6. D.C. Motors

(a) Principle; types and connections; parts and their functions

(b) Counter Emf., manual motor starters; methods of speed control; reversing D.C. motors; automatic starters; dynamic braking

(c) Load characteristic curves of shunt, series and compound motors; per cent speed regulation; armature reaction and interpoles

(d) Losses and efficiency

(e) Motor applications

7. Alternating Current

(a) An introductory study of alternating emf. generation; the sine wave, frequency, average, effective and maximum values

(b) Inductance: definition, factors affecting inductance and inductive reactance, formulae and units; phase relations; non-inductive windings; inductors in series and parallel; application

(c) Capacitance: definition, types, construction and operation of capacitors; factors affecting capacitance and capacitive reactance; formulae and units; phase relations; capacitors in series and parallel; application

(d) Simple A.C. circuits, phase relationships, Ohm's Law A.C., impedance

(e) Vector diagrams for A.C. series circuits

8. Transformers

(a) Principle, construction, types and application

(b) Voltage and current ratios

9. Elementary Electronics

Refer to Grade 11 Electronics. The topics selected and studied will depend on the time and equipment available. This section is to be deleted if the students receive instruction in electronics in the electronics laboratory.

Grade 12

SAFETY: Safety precautions should be stressed.

1. The Sine Wave

    (a) Definition and construction of a sine wave; cycle, frequency

    (b) Review of average, effective (R.M.S.) and maximum values and the relationships between them; form factor of the sine wave

    (c) Equation of the sine wave, instantaneous values

2. Alternating Current Circuits

    (a) Review of inductance, capacitance, reactance and impedance

    (b) Application of Ohm's Law to alternating current circuits

    (c) Phase relationships in A.C. series and parallel circuits; vector diagrams; series and parallel resonance; characteristics of resonant circuits; resonance curves

    (d) Power waves for A.C. circuits containing R, L, or C, frequency of power waves, positive and negative power, instantaneous, maximum and average power, effect of phase angle

    (e) Power and power factor: definitions, meaning of leading and lagging power factor; measurement of power in non-inductive, inductive and capacitive single phase circuits; the determination of power factor; the relationship between volt-amps, watts and vars; formulae and calculations of power and power factor

    (f) Power factor correction by capacitors

3. Polyphase Systems

    (a) Reasons for polyphase systems, elementary two phase and three phase alternators, star and delta connections

    (b) Vector diagrams for balanced loads in star and delta, unity p.f.

    (c) Calculation and measurement of three phase power (balanced loads)

4. Alternators

    (a) Construction of single and polyphase alternators, factors affecting voltage and frequency

    (b) Voltage control, armature reaction, per cent voltage regulation

    (c) Parallel operation of alternators (Optional): synchronizing by use of lamps and voltmeters, load adjustment between machines, effect of changing field excitation, hunting

5. Transformers

    (a) Construction, principle, voltage ratio, transformer equation, effect of loading a transformer, efficiency, commercial applications

(b) Polarity: definition, importance and determination

(c) Transformer connections: series, parallel, star, delta, open delta

(d) Load characteristics, losses and efficiency

6. Alternating Current Motors

(a) Explanation and demonstration of the revolving magnetic field, synchronous speed

(b) Three Phase Squirrel Cage Induction Motors: the principle, construction and commercial uses; a study of torque, slip, rotor speed and frequency starting current, starting torque, power factor and the operating or load characteristics

(c) Three Phase Wound Rotor Induction Motors: the principle, construction torque, slip, rotor speed and frequency, starting current, starting torque, power factor, speed control and operating or load characteristics; commercial uses

(d) Single Phase Induction Motors: the principles, construction and commercial uses of single phase induction motors; a study of special starting devices, arrangement of windings, starting currents, torque and speed characteristics, power factor and efficiency

(e) Synchronous Motors: the principle, construction and commercial uses of synchronous motors; a study of starting methods, motor speed, power factor and power factor correction; characteristic curves

(f) Motor Control: the principles, types and construction of starting and control devices in common use for induction and synchronous motors

7. Instruments

Note: The proper use and care of instruments should be stressed.

The theory of operation; use and circuit connections for ammeters, voltmeters, wattmeters, oscilloscopes, vacuum tube voltmeters and insulation testers

8. Power Rectifiers

The construction, theory of operation, characteristics and precautions to observe when selenium, silicon, controlled solid state and gaseous rectifiers are used commercially in single and polyphase circuits. Applications

9. Industrial Electronic Circuits

Refer to Grade 12 Industrial Electronics. The topics selected and studied will depend on the time and equipment available. This section is to be deleted if the students receive instruction in the Electronics Laboratory.

ELECTRONICS

Five-Year Programme Grades 11 and 12

Grade 11

SAFETY: Safe practices in the handling of electrical and electronic equipment should be stressed.

This course material to be expanded or modified as time permits. It is assumed that the students have a background in electrical principles. If this is not the case, the course should be modified to include the principles required.

1. Vacuum Tubes

   (a) Types of emission with emphasis on thermionic emission

   (b) Types of cathodes

   (c) Physical construction of diodes and triodes

   (d) Characteristics of diode and triode tubes

   Laboratory Work

   Experimental determination of tube parameters

2. A.C. and Magnetism

   (a) Principles of magnetism and electro-magnetic induction with reference to the generation of A.C.

   (b) Nomenclature of A.C., characteristics and values

   (c) Introduction to vectors

   (d) Introduction to capacitance

   (e) Introduction to inductance

   (f) Analysis of L.C.R. circuits

   Laboratory Work

   (a) Use of oscilloscope and other instruments in analysis and measurement

   (b) Colour codes for resistors and capacitors

   (c) Experimental analysis of L.C.R. circuits

   (d) Analysis of various meter movements

3. Diode Applications

   (a) Power supplies

   (b) Detectors

Laboratory Work

(a) Waveform and voltage analysis of half-wave and full-wave power supplies

(b) Experimental study of filter circuits

(c) Experimental study of regulation as determined by the type of filter circuit and load conditions

(d) Experimental study of an L-C circuit used with a diode detector

4. Triode Applications

Amplifier: biasing methods; classes of operation; methods of coupling; circuit analysis of audio and radio frequency amplifiers

Laboratory Work

(a) Production of bias voltage by various experimental methods

(b) Experimental analysis of voltage amplifiers, phase inverters and push - pull circuits

(c) The application of the triode as an oscillator

(d) The application of the triode as a detector

5. Solid State Devices

(a) Review of the Bohr atom with emphasis on energy levels in semi-conductor materials

(b) The P-N junction

(c) Transistors: principles, construction, types, advantages and disadvantages in comparison with vacuum tubes; amplifier configurations; introduction to hybrid parameters

Laboratory Work

Experimental study of typical simple transistorized devices

Grade 12

SAFETY: The precautions necessary to avoid high voltage shock and the care necessary in handling chassis and picture tubes should be emphasized.

This course material to be expanded or modified as time permits. It is assumed that the Grade 11 Electronics Course has been completed.

1. Superheterodyne Receiver

(a) Block diagram of receiver

(b) Review of power supplies

(c) Review of audio amplifiers

(d) Superheterodyne principle

(e) Circuits used for frequency conversion

(f) Study of I.F. amplifier

(g) Study of diode detector

Laboratory Work

Construction of a superheterodyne receiver by stages as follows: (Experiments should be conducted following the completion of each stage)

(a) Power supply including filament circuit

(b) Audio system

(c) I.F. amplifier and detector

(d) Converter

(e) Complete alignment of receiver

2. Fault Analysis

(a) Classroom demonstrations of various fault finding techniques

(b) Voltage and resistance analysis of the receiver

3. Special Circuits

The following topics to be presented as lecture demonstrations if time permits

(a) Electronic voltage regulation

(b) Circuit protection

(c) Volume control and tone control circuits

(d) Factors influencing frequency response

(e) Methods of connecting a record player to a radio

(f) Tuning indicators

(g) A.V.C. and D.A.V.C. circuits

(h) Squelch and noise limiter circuits

4. Gaseous Tubes

The study of gas diodes and triodes and the application of these tubes as rectifiers, regulators and control devices

5. Industrial Control

Experimental study of typical circuits to illustrate the application of vacuum tubes and solid state devices for electronic control such as photo-electric relays and time-delay relays

6. Television

A basic understanding of the operation of a television receiver; an appreciation of the function and adjustment of the controls

Laboratory Work

Adjustment of a T.V. set

INDUSTRIAL CHEMISTRY

Five-Year Programme Grades 11 and 12

Grade 11

1. General Chemistry

When pupils plan to write the Departmental Examination in Grade 13 Chemistry at the end of the Grade 12 Industrial Chemistry Course, the teacher should ensure that all topics listed in the Grade 13 Course of Studies are covered. In Grade 11 many experiments should be done by the student to establish a firm understanding of equivalent weights, gas laws and vapour pressure.

(a) The atom: structure, size, weight, representation, quantum energy levels

(b) Why atoms unite: valence, covalence

(c) Periodicity: atomic table

(d) Activity: development of activity list from experiments

(e) Ionization: conductivity experiments, coloured ions, ionic equations

(f) Reactions and equations: review of equations, practice in writing equations; hydrolysis with experiments; electrolysis with experiments, Downs cell, Hall cell, Gibb cell; experiments on equivalent weight

(g) Metals: iron, cobalt, transition elements, principal properties of metals

(h) Oxidation - reduction: examples, tests in terms of electron transfer

(i) Equilibrium: reversibility; law of mass action with experiments; dynamic equilibrium; Le Chatelier's principle; Haber process

(j) Ionic equilibrium: acid-base theory; common-ion effect; solubility product and ionization constant

(k) Co-ordination: complex ions

2. Qualitative Analysis

Qualitative analysis provides a good review of chemical principles and an opportunity to work out equations. This topic embraces a study of the application of mass action, ionization, solubility product, co-precipitation, common-ion effect, buffers and pH control

Note: Semi-micro methods may be used to save time and chemicals and to encourage closer observations.

3. Gravimetric Analysis

(a) The construction, care and use of balances: precision; sensitivity; rest point

(b) Determination of: water of crystallization in a hydrated salt; barium in barium chloride; chlorine in barium chloride; iron in ferrous ammonium sulphate; nickel in steel

Grade 12

1. General Chemistry

   Continuation and completion of Grade 13 Chemistry

2. Volumetric Analysis

   Comparison with gravimetric analysis with regard to accuracy, speed and basis of calculations (mole, molar; equivalent, normal)

   (a) Accuracy of pipettes and burettes

   (b) Making normal solutions: e.g., hydrochloric acid, sodium hydroxide; primary and secondary standards

   (c) Review of pH, theory of indicators, end points, mixed indicators; titration curves (optional)

   (d) Determining the percentage of: acetic acid in vinegar; oxalic acid in a cleaner; sodium hydroxide and sodium carbonate in commercial caustic, soda ash, borax and boric acid

   (e) Preparation of a standard permanganate solution and standardization against a ferrous salt and sodium oxalate

   (f) The principles of reduction using stannous chloride, Jones reductor and hydrogen

   (g) Determination of the iron in a ferric salt

   (h) Preparation of a standard iodine solution and a standard thiosulphate solution; determination of copper

   (i) Determination of chlorine in bleach

3. Instrumental Analysis

   A study of the principles involved and the applications in process control of the following instruments: saccharimeter or refractometer, pH meter, automatic titrator, Nessler tubes and colorimeter, photoelectrometer. fluorimeter, nephelometer, polarimeter, spectrophotometer, Parr bomb calorimeter, viscometers

4. Photography (Optional)

   This study is to enable the technician to preserve records of laboratory set-ups, and make micro-photographs and illustrations of processes and machinery.

   Mixing developer and fixer; developing the negative; printing by contact; camera values; film speeds; exposure meters; grades of paper; copying and enlarging; mounting; lenses; light; depth of field; filters; light and shadow effects; slide making; intensifying; reducing; dodging and special effects

5. Organic Chemistry

(a) The large number of organic compounds and their importance

(b) Nomenclature

(c) The carbon tetrad or tetrahedron; covalent carbon

(d) Determination of percentage composition of carbon compounds

(e) Graphic and structural formulae; isomers, homologues

(f) The petroleum industry and its products: alkanes, alkenes, alkynes, botted gases, polymers; the cracking process, extraction of products

(g) Alcohols: production and industrial uses

(h) Aldehydes as oxidation derivatives

(i) Ketones

(j) Acids: final product of oxidation; fatty acids; unsaturated acids

(k) Esters: soap, paint, perfume

(l) Comparison of syndets and soaps; soap manufacture; glycerol and its uses

(m) Alkyl halides: ethyl bromide, methylene iodide, chloroform

(n) Ethers: dimethyl, diethyl, dioxane, ethylene oxide and cellosolve

(o) Acid chlorides as reagents

(p) Acid anhydride and chloral

(q) Hydroxy acids: glycolic, malic, lactic

(r) Dicarboxylic acids: oxalic, tartaric, succinic

(s) Amides: acetamide, urea, thiocarbamide, plastics

(t) Amines: reducing agents, deoxidants, ethanolamine and triethanolamine

(u) Cyanogen derivatives

INDUSTRIAL PHYSICS

Five-Year Programme Grades 11 and 12

Grade 11

It is understood that the regular Departmental course in Science for Grade 11 will be studied in addition to the topics outlined below.

Students should be given ample opportunity to perform experiments and use equipment.

Weekly problems should be assigned on the topics studied to provide experience in their solution and to clarify and drill the principles involved.

1. Energy, Work and Power

   (a) Energy and Work: the meaning and relationship between energy, (P.E. and K.E.), work and power; efficiency; C.G.S., M.K.S. and F.P.S. gravitational and absolute units for measurement; derivation of the formulae, P.E. = mgh and K.E. = $\frac{1}{2}mv^2$

   Experiments involving the inclined plane and the mechanical equivalent of heat

   (b) Power: the meaning of power; introduction of the watt, kilowatt and horsepower; brake horsepower using the Prony brake

2. Friction

   (a) Static, kinetic, rolling and fluid friction; experimental determination of the coefficient of friction, factors controlling friction

   (b) Lubrication

3. Magnetism and Electricity

   Note: 1 Wherever possible the topic of current electricity should be taught in the electrical laboratory.

   Note: 2 Experiments should be performed or demonstrated to illustrate the topics.

   (a) Magnets and Magnetism: characteristics and laws of magnetism; properties of magnetic lines of force, theory of magnetism with experiments to illustrate; terrestrial magnetism; magnetic fields about a conductor carrying a current, Right and Left Hand Rules; electro-magnets and solenoids; factors affecting the strength of electro-magnets; hysteresis; the application of the electro-magnet in bells, relays and solenoid switches

   (b) Electrostatics: positive and negative electric charges; the Electron Theory; the meaning of electrical potential difference; capacitors and capacitance; a volt as one joule per coulomb; proof of a charge on the terminals of a battery; charging by induction; shielding; the escape of a charge from a point; lightning rods

   (c) Current Electricity: review of the Electron Theory; review of voltage, current, resistance and their units of measurement, Ohm's Law; series circuits, parallel circuits, series - parallel circuits; wire table; formula for the resistance of wires; electrical power; induction coils

Generators: principles of A.C. and D.C. generators; parts and their functions, types and connections (schematic diagrams); effect of field flux and speed on voltage; factors affecting alternator frequency; single and polyphase generators; characteristic curves; application

D.C. Motors: principle; parts and their functions; types and connections; motor counter emf; methods of starting motors; speed control; speed characteristics; application

Alternating Current: the sine wave, cycle, frequency, maximum and effective values of sine wave voltage and current; inductance in D.C. and A.C. circuits; phase relations, vectors; resistance, inductive reactance, impedance, application of Ohm's Law to A.C. circuits; capacitance and capacitative reactance; the series A.C. circuit, vector diagrams; series resonance; power, power factor, phase angle; transformers. Three Phase: three-phase voltage and current; star and delta connections

A.C. Motors: a study of the principles, connections, speed characteristics and application of universal, three-phase induction, three-phase synchronous, and common single phase motors

Instruments: the D'Arsonval galvanometer, the D.C. ammeter and voltmeter, the ohmmeter and the wattmeter; A.C. ammeters and voltmeters

4. Strength of Materials

(a) Simple Stresses: review of forces and units; vector quantities; external and internal forces, equilibrium, action and reaction; tension and compression stresses; shearing stresses; stresses in thin pipes, cylinders and welded joints; safety factor

(b) Properties of Materials: kinetic molecular theory and crystal lattice; stiffness, elasticity, toughness, ductility, hardness, malleability, strength, endurance limit; elastic properties of metals, Hooke's Law; Young's Modulus; Poisson's Ratio; temperature stresses

(c) Beams: theory, types and comparative strength, shear diagrams, bending moments, concentrated and distributed loads; section modulus

(d) Torsion: solid and hollow shafts, transmitted horsepower, helical springs

(e) Metals and Non-Metallic Materials: characteristics, structure and properties

(f) Testing methods: a study of tensile, compression, bending, hardness, impact, torsion, microscopic, supersonic and x-ray tests

(g) Industrial Processes (Optional)

Grade 12

Students should be given ample opportunity to perform experiments and use equipment.

Weekly problems should be assigned on the topics studied to provide experience in their solution and to clarify and drill the principles involved.

1. Accurate Measurements

A complete review of Grade 11 measurements, C.G.S., M.K.S. and F.P.S. systems and their use, specialized units for hardness, viscosity and hydrometry as applied to local industries

2. Sound

Superposition of waves to get quality and standing waves; laws of vibrating strings; harmonics and fundamental frequencies; resonance in air columns; sound interference and beats; Herschel's divided tube; sympathetic vibrations; the ear; acoustics; industrial applications

3. Light

Units of measurement - C.P., ft. candles, lumens, lamberts and foot-lamberts. Photometry to obtain C.P.; optical instruments; the spectroscope for spectroscopic analysis; interference of light by soap film and air wedge; measurement of the wave length of sodium light by air wedge; the electro-magnetic spectrum; the diffraction grating and Newton's rings; ultra-violet and infra red radiations, three dimensional pictures; the human eye, persistence of vision, eye fatigue and colour blindness

4. Hydraulics and Pneumatics

(a) Fundamentals: concepts and definitions of fluids, solids, liquids and gases; density, specific gravity; hydrometry; Baumé and Twaddle Scales; compressibility and elasticity

(b) Fluids in motion: fluid flow, streamlines and tubes of flow; flow through a constriction; Bernoulli's Principle; effect of friction on flow; viscosity, air foils; discharge from an orifice; turbines; osmosis

(c) Gas Laws: air pressure; measurement of air pressure; Boyle's Law; Charles' Law; elasticity, pressure gauges and barometers; diffusion and vapour pressure

(d) Industrial Uses: fluid couplings, fluid measuring instruments, fluid pumps, fluid motors, fluid power and control systems; automation equipment; hydraulic presses, hydraulic lifts and other industrial applications of hydraulics

5. Electronics

Note: Wherever possible this topic should be taught in the electronics laboratory.

Electron emission, electronic tubes; half-wave and full-wave rectification; the triode tube; the triode as an amplifier, rectifier and oscillator; the thyratron and its characteristics, phase shift circuits; interpretation of schematic diagrams; magnetic amplifiers; voltage doublers and three phase rectifiers; high frequency induction and dielectric heating; photo relay circuits. Industrial applications of diodes, triodes, transistors and thermistors

6. Nuclear Physics (Optional)

MACHINE SHOP PRACTICE

Five-Year Programme Grades 11 and 12

Grade 11

In view of the limited time allotment and the aims and objectives of this programme, demonstrations, exercises and assignments should replace the usual project method of instruction. The course is intended to emphasize the technology of machining practices and the capabilities of the machines and tools involved.

SAFETY: Proper safety measures in the use of tools and equipment must be observed.

1. Measurment

   A study of the vernier principle and its application to measuring tools. The purpose and application of the vernier micrometer, inside micrometer, depth micrometer, vernier caliper, telescoping gauges, dial indicator, thickness gauges, profile gauges and gauge blocks. The three-wire method of measuring threads. The importance of cleanliness in precision measurement. The care and storage of precision instruments

2. Hand Tools and Bench Work

   Types, characteristics, care and use of hand reamers. Reaming parallel and tapered holes, precautions and allowances

3. Layout Work

   Layout work involving the use of the vernier protractor, the vernier height gauge, the surface plate, the surface gauge and precision V block

4. Machine Tools

   (a) Lathe: the internal construction of the headstock, apron and tailstock; cutting speeds and feeds; aligning centres; applications and methods of form turning; a study of the angles and cutting action of lathe cutting tools; hand grinding of lathe cutting tools; cutting right and left hand Unified threads, calculations and applications; taper turning and fitting to a gauge; steady and follower rest applications; drilling, boring and reaming; a study of work-holding devices such as lathe mandrels, face plates, collets and 3-and 4-jaw chucks; pulley and gear ratios as applied to speed and feed changes, back gears and thread calculations

   (b) Drill Press: types of drill presses; drilling, countersinking and counterboring various metals; types, characteristics and use of machine reamers; a study of work holding devices such as clamps, jigs and fixtures; production drilling techniques

   (c) Shaper: cutting speeds and feeds; shaper cutting tools, angles, materials and cutting action; principles of the operating mechanisms (speeds, feeds, fast return); a study of shaper operations such as external and internal keyway cutting, serrating, machining irregular and angular surfaces

   (d) Horizontal Milling Machine: speeds and feeds; a study of work holding devices, such as clamps, vises and fixtures; type of milling cutters, selection and application; conventional and climb milling applications; a study of milling operations such as side milling, straddle milling, sawing, slitting, end milling, form milling and fly cutting; milling machine attachments and their applications; direct and plain indexing, spur gear cutting; purpose and application of cutting fluids

(e) Vertical Milling Machine: a study of vertical milling machines and their application; relationship of speed and feed rates, depth of cut and cutter diameter for various materials; a study of vertical milling attachments and operations

(f) Pedestal or Bench Grinder: grinding lathe and shaper cutting tools; principles of drill grinding; grinding drills; truing and dressing wheels, adjusting work rests

(g) Surface Grinders: a study of surface grinders, types and applications; names of operative parts; a study of the construction and use of magnetic chucks and demagnetizers; grinding wheel construction, characteristics and marking systems; truing, dressing and balancing a grinding wheel; grinding of flat, square, parallel and angular surfaces

(h) Portable Grinders: types and application of portable grinders for lathe and bench work

(i) Contour Cutting Band Saw: types, sizes and care of contour cutting band saws; identification of the main parts and operating controls; a study of the interrelation of speed, feed, material and type of blade; contour sawing, band filing and friction sawing operations

5. Metallurgy

The manufacture of irons and steels; the S.A.E. system for classifying steels; a study of the composition, characteristics and application of ferrous and non-ferrous metals; a study of the characteristics of steel in relation to its carbon content (hardenability, tensile strength and ductility); an experimental study of the purpose and resultant effects on steel of the following heat treatment operations: hardening, tempering, annealing and normalizing

Grade 12

SAFETY: The development of good safety habits should be emphasized.

1. Measurement and Inspection Procedures

Use of the gear tooth vernier caliper, thread micrometer, small hole gauges, gauge blocks, sine bar, sine plate, standard measuring rods, vernier height gauge, dial indicator, master square, comparator and other gauges
Surface analysis
Temperature and dust control in precision measurement

2. Hand Tools and Bench Work

Purpose and procedure in precision finishing methods such as filing, scraping and lapping. Theory, application and lubrication of bearings such as sleeve, babbit and anti-friction. Theory and application of machine fits such as running, push, driving, force and shrink

3. Layout Work

Precision layout and locating by means of tool-makers' buttons, trigonometrical calculations, sine bar, gauge blocks, vernier height gauge, and precision planer gauge
Cam layouts

4. Machine Tools

(a) Lathe: investigation, application and calculations for the following threads; Acme, Square, internal and multiple start threads; precision alignment and locating with the dial indicator; theory and application of form turning tools; the principle and application of the tracing attachment, backing-off attachment, turret tool post and other attachments that widen the range and increase the productivity of the lathe; the principle of relieving form cutters using a backing-off attachment

(b) Horizontal Milling Machine: the calculations involved in differential indexing, helical milling and cam milling; a study of cam types, motion, layout and application; production of helical, bevel and worn gears and their application; a study of tooth construction and materials for simple and multi-tooth milling cutters; boring with a fly cutter and micrometer boring head
Where operations are performed they should be precision milling operations incorporating the use of graduated collars, dial indicators, gauge blocks and tool-makers' buttons

(c) Vertical Milling Machine: the vertical mill as a jig borer and the principle of precision locating with gauge blocks, dial indicators, measuring rods or optical gauges, edge finder, center finder and locating microscope; the rotary table and its application; diesinking operations and the principle of duplication with tracer control

(d) Grinding: a study of grinding wheels; cutting action, types, selections and application; interrelation between speed, feeds, wheel characteristics, and nature of operation in internal and external cylindrical grinding, cutter grinding, and surface grinding; a study of heat control in grinding; the principles of crush dressing and form grinding; a study of grinding problems, causes, effects and remedies; comparison of production grinding and tool room grinding

5. Metallurgy

A study of the principle and application of the thermocouple and pyrometer; an advanced study by experiment of the granular structure of heat treated steels; further experiments in hardening, tempering, quenching, carburizing, annealing and normalizing; a study of the properties of alloy steels, their uses and heat treatment; hardness testing methods such as Brinell, Rockwell and Scleroscope; experiments in tensile, compression and shear testing of samples and standard manufactured products

6. A study of the composition, purpose and application of carbide and ceramic cutting tools

7. Tool Making

Types of work done by the diemaker, jig and fixture-maker, mouldmaker and special machine builder; types and applications of dies, moulds, jigs and fixtures; construction of punches and dies, moulds, jigs and fixtures

8. Hydraulics

A study of the principles involved in the hydraulic control of machine movements such as pumping mechanisms, valve mechanisms, hydraulic cylinders and hydraulic motors

9. A study of the principle and application of recent developments in the machine industry such as electrical discharge machining, electro-chemical machining, numerical control of machine tools and powder metallurgy

SCIENCE, TECHNOLOGY, AND TRADES BRANCH

Two-Year Programme

Pupils at least fourteen years of age who have been promoted to a secondary school and who declare with their parents concurrence that they plan to leave school for employment in two years (age 16) may take, where it can be made available, a special Two-Year Programme.

Technical Subjects of practical value in obtaining employment after two years in a secondary school are to receive approximately forty per cent of the instructional time in the first year and fifty per cent in the second year. During the first year, the pupils receive instruction in a group of Technical Subjects including Drafting. In the second year it is expected that the pupils will select one practical subject as a major subject, this and a related technical subject or subjects accounting for fifty per cent of the pupils' time.

The related Technical Subjects should be such as to complement the work of the major Technical Subject selected.

An outline of a course in Drafting is included and this may be taken as a related Technical Subject if desired. It is expected that teachers will develop other courses for related subjects in the Two-Year Programme.

A pupil who has completed the work of either one or two years of a Two-Year Programme and had demonstrated superior ability may be transferred to the Four-Year Programme of the Branch concerned subject if necessary to repeating all or a portion of a year's work in the latter programme.

Pupils who conform to the requirements of the Two-Year Programme and complete the courses successfully may be granted, on the recommendation of the Principal, a Departmental Certificate of Standing.

Successful completion of any course of study in the Two-Year Programme does not necessarily qualify the pupil as an apprentice under the apprenticeship act. Persons intending to become apprentices in any trade must comply with the requirements of that trade.

Course outlines are contained herein for the following practical subjects.

Practical Subjects

Carpentry
Drafting
Dry Cleaning
Electrical Construction
Graphic Arts
Machine Shop Practice
Masonry
Painting and Decorating
Service Station Operation
Sheet Metal
Small Engines
Welding

CARPENTRY

Two-Year Programme Grades 9 and 10

Grade 9

This course is designed to stress the practical applications of carpentry and to develop manipulative skills and a pride of workmanship.

The aim of this course may be accomplished through the introduction of practical projects which illustrate the variety of work done by the carpenter and which should provide a stimulus to the pupil to proceed into an area where he will have acquired salable skills.

SAFETY: Emphasize safe practices in the use of hand and power tools and the development of a proper regard for personal safety and the safety of others.

1. Materials
   (a) Wood structure: sawing, seasoning; classification, hard and soft, board measure; defects in lumber, stock sizes, measurements
   (b) Wood fasteners: nails, screws, bolts
   (c) Wood adhesives: types, characteristics, application
   (d) Wood finishes: practical kinds and their uses

2. Hand Tools

   As applicable to the industry (saws, planes, etc.); sharpening keen edged tools, safe handling and care; sanding, use of coated abrasives

3. Machine Tools

   Safety instruction; operation of saws: radial, circular, jig and band; surfacers: jointer, planer; boring: drill press and mortiser

4. Portable Tools
   (a) Safety instruction, cords, grounding
   (b) Sanders: belt and vibrator
   (c) Saws: sabre
   (d) Drills: boring tools

5. Bench Work
   (a) Common joints: names, uses
   (b) Assembly: use of holding devices (clamps)

6. House Framing (Corner Section to scale)
   (a) House parts: names, purposes

(b) Blueprint reading: architectural drawings

(c) Box sill construction: plates, headers

(d) Joists: headers, trimmers, bridging

(e) Sub-flooring: materials and methods of installation

(f) Wall framing: plates, sole, top, layout; corner post construction; studs: sizes, spacing; girths, braces, strengthening; openings: door and window sizes, headers, cripple studs; intersecting partitions, methods of construction

(g) Ceiling joist: sizes and spacing

(h) Roof framing: common rafter, open cornice

(i) Gable ends: framing methods

Grade 10

In keeping with the trend of current building practices, it is recommended that in this course, information and operations together with project planning should provide the student with ample opportunity to attain necessary experience which will contribute to his proficiency and skill.

If possible a suitable structure of adequate size to illustrate building principles and erection procedure should be built to provide student participation and practical application.

SAFETY: Stress safe practices in the use and care of hand tools and power equipment.

1. Construction Materials

   (a) Lumber: framing and dimension stock; plywoods and composite boards; grades and terms

   (b) Concrete blocks and sills: types and sizes

   (c) Brick and clay products

   (d) Sheet and corrugated sections: transite and other materials

   (e) Types of roof coverings

   (f) Builder's hardware

2. Equipment

   (a) Hand tools as applied to the industry

   (b) Portable machines: saws, drills and other portable power tools

   (c) Scaffolding: types and safety precautions

(d) Excavating and erection machinery

(e) Production machines

3. House Construction Details

(a) Plot plans and restrictions

(b) Footings and foundations

(c) Sills, anchor bolts, beams and girders

(d) Joists: spans, openings, headers, trimmers

(e) Bridging and sub-flooring

(f) Wall sections: exterior and interior, types of framing; partitions; plates, studs, girths, bracing; openings, headers, trimmers, cripple studs; door and window frames and sizes

(g) Ceiling joist and cornice construction

(h) Roof framing: common, hip and jack rafters

(i) Gable ends: framing and finishing

(j) Roof covering: sheathing and shingles

(k) Exterior sheathing and siding: types of materials

(l) Interior finishes: partitions; drywall, lath and plaster, insulation; frames and doors; trim and casings

4. Millwork

(a) Simple window frames and sash

(b) Straight stair construction

(c) Cabinets: kitchen and storage

5. Concrete Form Work

Types of forms, steel and wood; prefabricated forms; typical installations of forms as used for wall footings, walls and straight stairs

DRAFTING

Two-Year Programme Grades 9 and 10

Grade 9

The aims of this course are to teach the fundamentals of drafting and to give instruction in good drafting practices.

The drafting problems selected should be closely related to the technical work in which the pupils receive instruction in the shops.

Note: All work to be done according to C.S.A. Standards.

1. Development of Drafting Skills

   (a) The use and care of the elementary drafting instruments

   (b) The development of skill in single stroke freehand capital lettering; alphabets, figures and fractions. Application in notes and dimensions

   (c) Recognition through use of the alphabet of lines - visible outline, hidden line, centre line, dimension line, extension line, leader line, section line, cutting plane line and break line

   (d) Technique in measuring using the full size scale

   (e) One-view drawings such as templates, gates, street plan and plot plan to develop the skills required in using the instruments

2. Orthographic Projection (2 view to 6 view)

   Freehand sketching of orthographic views from pictorial representation and objects to illustrate the correct placement of views on working drawings and the differences between orthographic views and pictorial drawings

3. Working Drawings and Freehand Sketching

   (a) Two and three view sketches and working drawings to scale such as full size, half size and 3" = 1 foot of rectangular objects, angular objects which require straight lines only such as wedges and tapers, objects with curved surfaces involving circles and arcs

   (b) Spacing views for proper balance

   (c) Elementary dimensioning including the locating and dimensioning of circles, arcs and angles

   (d) Full sections and half sections; methods of indicating the section and the materials by cross-hatching, common materials only

   (e) Geometrical constructions to be included in the classroom drafting projects as required

4. Detail and Assembly Drawings

   (a) Detail drawings of simple parts to illustrate conventional indications for operations such as drilling, threading and tapping; finish marks. In introducing threading the simplified symbol should be stressed

   (b) Simple assembly drawings of two or more parts to show the relationship of the parts, the method of dimensioning the assembly and to introduce the bill of material and parts list

5. Blueprint Reading

   Considerable time should be spent in the study of blueprint reading of shop projects and other objects to learn the sizes, shapes, details, materials and processes as specified

Grade 10

Note: All work to be done according to C.S.A. Standards.

1. Orthographic Projection

   Problems to illustrate the principles of third angle projection: objects with surfaces not parallel to one another; auxiliary views

2. Pictorial Drawing

   The use of pictorial drawings expressed in such forms as isometric and oblique. Introduction of modern pictorial drawing practice including dimensioning

3. Machine Parts

   (a) Machine fastenings: selection of and correct specifications for machine screws, studs, bolts, nuts, washers, taper pins, cotter pins and retaining rings

   (b) Key and Key-seats

   (c) Threads: National and Unified; coarse, fine and extra fine threads, multiple threads, Acme and Square threads, right and left hand threads, pipe threads

   (d) Tolerance

   (e) Section Views: removed, revolved, phantom, broken out and assembly in section

   (f) Drawing of simple machine parts; drawing of machine parts from notes and sketches obtained by measuring actual objects

   (g) Selection and use of common metals and materials

   (h) Inking, pencil drawing on transparent paper and reproduction; use of lettering devices

   (i) Introduction to the complete decimal system of dimensioning

4. Geometric Construction

Drafting problems involving layouts such as the hexagon, octagon and pentagon; the division of circles and lines and the bisection of angles and lines (This work should be included in classroom projects)

5. Development of Surfaces

Developing patterns for rectangular objects; parallel line development of patterns for right and oblique cut cylinders, two piece elbows and scoops. Radial line development applied to conical and pyramidal shapes; extension of parallel line development to three-and four-piece elbows. Developments involving a combination of both methods for pattern layout may be made from paper or in the sheet metal shop,if available

6. Working Drawings

Working drawings of a more advanced nature involving placement and dimensioning of views, sections, symbols of materials and bill of material. The drawings should be selected from shop projects when suitable. The making of sketch plans before starting the scale drawings should be encouraged.

7. Blueprint Reading

Blueprint reading for machine trades, building construction and electrical trades. Reading drawings representative of the shop work taught in the school and the work done in local industries

8. Optional Topics

(a) Building Construction: simple floor plan, wall sections for frame and masonry

(b) Tracing and Reproduction of Drawings: the student who makes rapid progress in drafting should be given some practice in inking or pencil drawing on tracing paper

DRY CLEANING

Two-Year Programme Grades 9 and 10

Grade 9

1. Introduction

   Aims and purpose; shop and safety rules; historical development; present day development; glossary

2. Plant Types

   Plant size, services offered, solvents used, basic equipment

3. Receiving Goods

   Courtesy; customers' wants, reactions; appearance, speech, attitude, store and shop appearance; invoicing, pricing, identification; serviceable and unserviceable garments, trimmings, simple classifying

4. Shipping

   Verifying orders; quality control; points of inspection; finishes; scheduling - policy and delivery dates; pricing and invoicing; packaging - bags, boxes, folding articles

5. Delivery

   Customer relations; courtesy; customers' needs; appearance, speech, attitude

6. Dry Cleaning

   Principles of dry cleaning; preparing loads; prespotting and formulae; poundage reports; dry cleaning problems

7. Filtration

   Principles of filtration: simple and pressure

8. Distillation

   Atmospheric distillation

9. Drying Cycles

   Principles of drying

10. Spotting

    Equipment; use of equipment; spotting chemicals; spotting formulae; spotting techniques; assessment of garments and assessment of stains; spotting methods

11. Fabrics

    Identification and construction of fabrics

12. Heavy Finishing

    Equipment and maintenance; utility presses; steamers; puffers, vacuum units

13. Finishing Heavy Garments

    Long and short coats; trousers and skirts

14. Plant Maintenance

    Care of building; housekeeping; working conditions

Grade 10

SAFETY: Safe operating procedures in the dry cleaning industry should be emphasized.

1. Review of Grade 9 course

2. Delivery

   Serviceability of fabrics; services available; company policies; sales techniques; vehicle management; Highway Act

3. Solvents

   Perchlorethylene specifications; Stoddard Solvent specifications; testing; solvent analysis; humidity control; dry cleaning soaps

4. Filtration

   Types of filters, filter aids, filter hookups, precoating, filter problems and their solution

5. Filter Pumps

   Centrifugal, rotary suction and positive displacement types; solvent coolers, solvent heaters, solvent temperature control

6. Solvent Tanks

   Synthetic, petroleum

7. Distillation

   Vacuum distillation, cookers and sniffers, cleaning cycles, rinsing cycles

8. Drying Cycles

   Hot units, cold units, reclaiming the solvent and solvent vapours, fire regulations

9. Extractors

   Types, speeds, problems

10. Cleaning Unserviceable Garments

11. Spotting

    Equipment, use of equipment, spotting chemicals, spotting formulae, spotting techniques, assessment of garments and assessment of stains, spotting methods

12. Fabrics

    Identification and construction of fabrics; dye types, fibre types, sizings, shower proofing, flame proofing

13. Wet Cleaning

    Equipment, tools, maintenance; fabric serviceability, fabric identification and construction, method of processing - water, soaps, bleaches, digestors; techniques of wet cleaning garments; water analysis; soaps and detergents; bleaches; digestors

14. Heavy Finishing

    Equipment and maintenance, utility presses; steamers, puffers, vacuum units

15. Finishing Heavy Garments

    Serviceability of garments, temperatures, types of material, finishing standards

16. Silk Finishing Equipment and Maintenance

    Sleevers, puffers, finishing boards and steam irons, vacuum units

17. Silk Finishing

    Plain, fancy and bias cut dresses; hand finishing; special finishes

18. Types of Material

    Styles, temperatures, lays and techniques to finish dresses, finishing standards

19. Garment Storage

    Vault construction (refrigerated and dry vaults), vault and storage management

20. Furs

    Identification, cleaning, cleaning fur trimmed garments

21. Leather

    Identification, cleaning, finishing

22. Hats

    Cleaning and blocking

23. Tailoring and Garment Repair

Button installation, machine operation, turn cuffs on trousers, install ½ or full pocket, install zipper, alter collar, alter sleeve, alter waist, alter garment length, general repairs

24. Operation of Steam Plant

Principle of boilers, types of boilers, boiler assembly, boiler hookup and return, insulation, water treatment, boiler inspection and insurance

25. Management

Daily cash control, banking, accounts payable, accounts receivable, period statements, financial statements, profit and loss, services, public relations, production standard and quality

26. Sales Management

Daily sales and control, weekly sales and control, period sales statement, sales training, sales analysis

27. Advertising and Promotion

28. Personnel

Selection, training and relations

29. Plant

Layout and location

ELECTRICAL CONSTRUCTION

Two-Year Programme Grades 9 and 10

Grade 9

Note: In this course there should be less stress on the theoretical aspects of the topics listed below and a greater emphasis placed on the practical applications of the principles involved.

SAFETY: Safe practices in the use of electrical devices should be stressed.

1. Signal Wiring

(a) The study and construction of series and parallel circuits using lamps, bells and buzzers. Dry cells and a transformer to be used as sources of supply. Drawing schematic diagrams using standard symbols to represent the electrical circuits; tracing and checking the wiring against the schematic diagrams before operating

(b) One or more of the above circuits to be constructed using a multi-conductor cable

2. Electrical Connections

(a) Making a rat-tail, tee and western union joints

(b) Tinning a soldering iron; soldering fluxes; soldering

(c) Taping and weatherproofing

(d) Solderless connectors

3. Conductors and Insulators

An experimental study of common metals and non-metals as a basis for classification into conductors and insulators

4. Magnetism

(a) The study of the properties of magnets and of lines of force using filings, compasses and typical magnetic and non-magnetic materials

(b) The law of attraction and repulsion; a theory of magnetism

(c) The earth as a magnet

(d) Common types of magnets and their application

(e) Methods of magnetizing and demagnetizing

5. Electrical Units

(a) Simple experiments should be performed to provide an understanding of the meaning of voltage, current and resistance and the units for each; reading electrical instruments

(b) Meaning and units of power and energy; calculations

(c) Reading a Kilowatt-hour meter and calculating a simple energy bill

6. Electro-magnetism

(a) Plotting fields of force about conductors carrying current to develop the hand rule

(b) Winding an electro-magnet to specifications

(c) The factors affecting the strength of an electro-magnet

(d) A study of electro-magnetism as applied in electric bells, chimes, relays, circuit breakers and lifting magnets

7. Effects of Electricity

Thermal, chemical, electro-magnetic and electrodynamic effects; electrical shock

8. Circuit Protection

(a) Purpose, operation and rating of plug and cartridge fuses

(b) The protective value of a fuse and application to circuits in the home

9. Suggested Topics

(a) The disassembling and assembling of electrical devices

(b) Cleaning and reconditioning small electrical devices

(c) Writing reports

(d) Organizing and classifying wiring supplies

(e) Taking an inventory

(f) A study of the types and uses of wood screws, machine screws and nuts, machine bolts and other fastening devices used in electrical work

Grade 10

Note: In this course there should be less stress on the theoretical aspects of the topics listed and a greater emphasis on the practical applications of the principles involved.

SAFETY: Electrical hazards and the precautions to be taken should be stressed. All electrical work should conform to the regulations of the Hydro-Electric Power Commission of Ontario and local Supply Authority.

1. Splices and Joints

(a) Proper construction of joints used in lighting circuits

(b) A further study of solderless connectors

(c) Soldering, taping and weatherproofing.

2. Materials

(a) The recognition of common wires and cables according to size, insulation and use

(b) The identification by size and description of other common trade materials

(c) Conduit - cutting and threading

(d) Rods of various materials - cutting and threading

(e) Various metals e.g., steel, brass, copper and aluminum - drilling and tapping

3. Circuits

(a) Further study of signal systems to include the annunciator, the apartment door lock system, return call system, burgular alarm systems, master control systems and a simple telephone circuit. Drawing schematic diagrams using standard symbols; tracing and checking the wiring against the schematic diagram before operating

(b) Wiring of one or more of the above circuits using a multi-conductor cable

(c) A study of typical circuits as used in an average-sized residence; planning and installing circuits in non-metallic sheathed cable; using architectural plans and symbols; drawing schematic diagrams

(d) Installing typical circuit in armoured cable and in conduit

(e) The testing of circuits by means of a voltage tester and a voltmeter; the repair of electrical faults should be introduced as required

4. Circuit Protection

Construction, purpose and rating of special fuses; application of circuit breakers

5. Instruments

(a) Ammeters and voltmeters: circuit connections and precautions for their use; accurate scale reading

(b) Using an ohmmeter

6. Ohm's Law

(a) A review of the meaning and units of voltage, current and resistance

(b) Ohm's Law, experimental study

(c) Simple problems involving Ohm's Law

7. Conductors and Non-Conductors

(a) A more advanced study and experimental determination of the ability of metals, non-metals and solutions to conduct current

(b) An elementary study of the structure of the atom; elementary electrostatics

8. Electro-magnetism

(a) Plotting the fields of force about a helix carrying current to develop the hand rule; the effect of increasing the number of turns; increasing the current through the coil; the presence or absence of a magnetic core

(b) Electro-magnetism as applied to annunciators, door locks, relays and telephone receivers

(c) A study of an elementary transformer, its windings, construction and the basic principle of operation

9. Types of Electric Current

The meaning of D.C. and A.C. and the common uses of each

10. Elementary Testing and Repair

The testing of simple domestic electrical appliances and devices using a test lamp and an ohmmeter; making minor repairs; checking for adequate insulation by means of a "megger" or equivalent testing instrument after the repair has been made and before returning the device to service

11. Resistors, Resistance Measurement, Circular Mil Measure

(a) A study of common resistance materials used in electrical devices such as lamps and heaters

(b) Resistors: construction; ohmic and power ratings, application

(c) The American wire gauge; a brief study of the wire table

12. Analysis of Electric Circuits

Determination of current, voltage and resistance characteristics of typical series and parallel circuits

13. Voltage Drop

Measurement of voltage drop in electrical circuits; problems

14. Suggested Topics

(a) Physical examination of electronic components e.g., resistors, capacitors, inductors, electronic tubes and transistors

(b) The colour codes for resistors

(c) Simple diode experiments to demonstrate emission and rectification

(d) Construction of a half-wave rectifier

(e) A study of the construction, care and maintenance of storage batteries

(f) The elementary study and practice of preventive maintenance for electric circuits and equipment

(g) The principle of electroplating

(h) The study of a typical automotive electric system

(i) The layout, forming and punching of chassis

(j) Sorting, labelling and classifying stores; keeping inventory records

(k) Repair of table and floor lamps

GRAPHIC ARTS

Two-Year Programme Grades 9 and 10

Grade 9

Type Composition (Hand)

1. The California Job Case and Contents

   Character and purpose of the case; the lower case letters, plan and reason for arrangement; the capitals, numerals, punctuation marks, ligatures, spaces and quads

2. The Composing Stick

   Kinds, parts and adjustment; use, care, posture for setting; pulling a proof in the stick; distribution from the stick; justification; simple flush lines

3. Type

   Composition, parts, functions, fontage; characteristics of similar letters, how identified, type and print compared; point system of measuring; point system as applied to leads, slugs and other material

4. Hand Composition

   Spacing, justifying, centering, quadding; indention and justification as applied to regular paragraph work

5. Proofreading

   Introduction to the use of the principal marks and their meanings

6. Safety precautions applicable to equipment
7. Technical and Trade Terms
8. Careers in Printing

Letterpress Presswork

The Platen Press

Development of the platen press, parts, care and oiling, inking, hand feeding, cleaning form, washing-up, packing platen, regulating impression, setting gauge pins, gripper and adjustment, lock-up, safety precautions, technical and trade terms

Grade 10

SAFETY: Emphasize safe practices in the use of tools and equipment and in the handling of chemicals.

Note: It is suggested that the student would be better prepared to enter industry if he were to concentrate on either letterpress printing or offset lithography in this course.

Type Composition (Hand)

1. History of Printing (Gutenberg to Bodoni)

2. Review of Type Composition, Grade 9

3. Elementary Composition

    (a) Dumping and tying: methods, precautions and development of skill

    (b) Pulling proofs on the galley: advantages, procedure and standard of cleanliness necessary

    (c) Distributing from the galley

    (d) Correcting in the stick and on the galley: general classifications of corrections and proper procedure; special corrections including overrunning

    (e) Punctuation marks and spacing: standard practice for the spacing of the period, comma, hyphen, colon, semicolon, exclamation mark, question mark, apostrophe, dash, parentheses and brackets

4. Proofreading

    Reading and correcting assignments

5. Special Composition

    (a) Setting indentions: hanging, half-diamond, squared, diagonal, flush left and right

    (b) Tabular composition: rules for procedure in setting up a simple example of tabulated form

    (c) Leading

    (d) Initial letters: history, purpose, extent of use, rules for use in composition

    (e) Leaders and rules: examples, purpose, procedure for composition

    (f) Borders: purposes, common types, margins, procedure for making butted rule border and mitered border

6. Composing Room Equipment

    Hand mitering machine, lead and slug cutter, imposing stone, furniture and racks

7. Saw and Vertical Miterer

8. The Ludlow Typograph

9. Single Page Lockup

   Materials, uses, positions and procedure

Type Composition (Hand) Advanced

1. Study of Materials

   (a) Type faces: classification into basic groups—Roman, Italic, Text, Sans Serif or Gothic, Script or Cursive, Square Serif, Novelty; a comparative study of available faces in the shop, identifying characteristics; Roman subdivided into old-style, modern, transitional

   (b) Recognition of type faces, type specimen book

   (c) Type sizes: application of point system, fontage, alignment, shoulder depth

   (d) Type series

   (e) Type families: development from original face—italic, bolder, lighter, condensed, extended; unity with variety

   (f) Letter-spacing: examination of various faces for proper letter-spacing

   (g) Rules, borders and ornaments: brass, machine, foundry; faces and body sizes, fontage, purpose, use, suitability

2. Elementary Principles of Display

3. Planning a Job

   Steps in planning any piece of job-printing or advertising—analysis of copy, choosing important or salient points, selection of type faces and making sketches

4. Job Composition

   A number of jobs from layouts or reprint copy to be set, proofed, read, corrected, and revised. This work to consist of many types of job work, e.g., business cards, envelopes, letterheads, tags, labels, rule forms and advertising; some may be broken for two colours and run on the press

Letterpress Presswork

SAFETY: Dangers and precautions as applicable to the equipment.

1. Review of Grade 9 Presswork

2. Hand-Fed Platens

   Putting a job on the press: reading work docket, preparing press, putting form on, precautions, positioning, elementary make-ready, checking and proofreading "final OK", hand feeding

3. Automatic Presses

   Parts, lubrication, feed mechanism, delivery, inking system, impression and packing, lock-up, auxiliary equipment

4. Kinds of cuts used in printing (originals and duplicates)

5. Use of Type-High Gauges

6. Stock Handling

   Handling of stock before and after printing; cleanliness, jogging, drying

7. Paper

   Mechanical and chemical pulps, sources of pulp, resultant paper, paper calculations, basic weights and sizes

8. Ink

   Types of ink, suitability to paper, drying, manufacture

9. Rollers

   Types of rollers; manufacture; glue and non-glue; care and cleanliness, proper wash-up solvent, setting

10. Make-ready

    Underlays, overlays, interlays; standard marks used in marking out a make-ready sheet; positioning. Special make-ready, scoring, creasing, etc.

11. Press Troubles and Remedies

12. Technical and Trade Terms

Offset Printing—Plate Preparation

1. Cleanliness and Care in Handling. Safety Precautions

2. Types of Plates Available

   Light sensitive, paper and metal; direct image, paper and metal

3. Copy Preparation

   Repro proofs, typewritten, individual letters, reprints, paste-ups, art work

4. Auto-positive Film

   Handling of light-sensitive materials, developing and fixing, time and temperature factors

5. Mounting and Stripping

   Tools and equipment, positioning, windows, opaquing

6. Exposing the Plate

   Method of exposure, time and light factors; developing chemicals and their proper use

Offset Printing—Plate Preparation Advanced

1. Making a Negative—Line Copy

   Construction of the camera; the process lens; illumination; scaling copy; arranging the copy; positioning the lens, lights and ground glass; focusing the image (same size); focusing the image for enlargements and reductions, tapes, per cent or coding; handling the film; exposing the film, time and light factors

2. Cleanliness and Safety Factors in Handling Chemicals

   Avoiding occupational dermatitis; effect of dust on film and negatives

3. Developing the Negative

   Organization of the darkroom; preparation of chemicals for developing; effect of time and temperature; developing to an appearance and to a fixed time; rinsing and fixing the negative; rinsing and drying the negative

4. Types of Cameras

   Parts and their function; overhead, horizontal, vertical, galley

5. Copy Preparation

   Suitable copy; working with poor copy; over and under exposing

6. Mounting and Stripping

   Scribing lines and touching-up broken image; corrections in negatives; opaquing, types of opaque and advantages; positioning of several elements of copy; page imposition; fold and cut marks

7. Making the Plate (Presensitized)

   Types of plates, advantages and cost factors; use of step guide; time and light factors; positioning flat on plate; exposing plate; developing the image; washing and gumming the plate

8. Causes of Plate Failure

   Poor plates and how to avoid them; uneven coatings, hot spots under and over exposure; spreading of the image; use of long-run lacquer

9. Types of Exposure Frames and Sources of Light

   Pressure frames and vacuum frames; incandescent, fluorescent and arc; protection of eyes from light sources.

10. Chemistry of Light-Sensitive Materials

    Chemicals, their compounding and application; effect of light on the coatings

11. Technical and Trade Terms

Offset Printing—Presswork

1. Outline of the development of the Offset Process, advantages over direct lithography; 2 and 3 cylinder principles

2. Care of the Press

   Lubrication and cleanliness; wash-up

3. Safety Precautions

4. Press Chemicals

   Plate etch, fountain etch, plate gum, blanket wash, water, ink

5. Press Controls and Adjustments

   Inking system, dampening system, feeder mechanism controls and operation, delivery adjustments

6. Operating Adjustments

   Balance of water and ink, handling of inks and chemicals, cylinder pressures

7. Types of Plates

   Suitable chemicals and treatment on the press, proper storage and care of plates

Offset Printing—Presswork Advanced

1. Application and Growth of Lithography

2. Servicing Dampening System

   Setting dampener rollers; recovering dampeners with molleton or paper covers; pumicing and etching metals; names and function of parts

3. Servicing Inking System

   Setting rollers; deglazing rollers; cleanliness; names and functions of parts

4. Lithographic Inks

   Ingredients, drying additives, suitability to paper

5. Papers

   Finishes, grain, standard sizes, weights; care in handling and storage

6. Chemistry of Presswork

   Ingredients of press and plate chemicals; ph what it is and its proper control

7. Set-off Precautions

   Paper handling; hazards and limitations in the use of dry and wet sprays

8. Blankets

   Care in normal use; changing and rotating, proper tension

9. Presswork Problems and How to Overcome Them

   Scumming, tinting, walking off, streaking, register, etc.

10. Technical and Trade Terms

MACHINE SHOP PRACTICE

Two-Year Programme Grades 9 and 10

Grade 9

SAFETY: Stress safe working procedures and safe practices in the use of tools and equipment

1. Hand Tools and Bench Work

   Description of and proper use of the following: soft and hard-faced hammers, chisels, punches, files, hand hacksaws, taps and dies, vises, standard wrenches, screw drivers, letter and number stamps, and abrasive cloth

2. Layout Work

   To prepare metal surfaces for layout with copper sulphate, chalk and layout dye; to layout work from blueprints or drawings using the steel rule, combination set, divider, scriber, hermaphrodite caliper, surface gauge, layout punch and centre punch

3. Measurement

   To measure with a steel rule and outside calipers; reading of outside micrometers and graduated collars

4. Machine Tools

   (a) Lathe: types and sizes; the care and lubrication of lathes; identification of the headstock, tailstock, drive plate, centres, bed, carriage and operating controls. To set up for and perform the following operations: parallel turning, facing, turning to a shoulder, grooving, turning a taper using compound rest and tailstock offset methods; knurling, filing and polishing. The construction features and applications and 3 and 4 jaw chucks and practice in their use

   (b) Horizontal milling machines: types, sizes and care of horizontal milling machines; identification of the column, knee, saddle, table, arbor, spindle overarm, arbor support and operating controls; plain milling; side milling

   (c) Vertical milling machines: types, sizes and care of vertical milling machines; comparison of horizontal and vertical milling machines; identification of the column, knee, saddle, spindle and operating controls; milling a plain surface, milling work surfaces at right angles

   (d) Drill press: types, sizes and care of drill presses; identification of the base, column, table, quill, spindle and operating controls; twist drill parts. The pupil should be made familiar with the setups for the following operations: drilling with the work held in a vise; drilling with the work clamped to the table; drilling a blind hole, drilling a hole; drilling a hole through the diameter of a cylinder; countersinking; drilling with the aid of a jig

(e) Pedestal or bench grinder: identification of the column, spindle, guards, rests; instruction in safe operating practices; eye protection, position of work rests and guards; offhand grinding practices

(f) Power saw: types and care of power saws; setting up and cutting work to length; cutting fluids

(g) Shaper: identification of the frame, column, ram, cross rail, saddle, table, table support, tool head and operating controls; shaping a plain surface; shaping a rectangular block

5. Hot Metal Working

Operating a forge or furnace; simple forging; simple hardening, tempering and case hardening

6. Finishing

Draw filing, polishing, rust proofing, abrasive belt and disc grinding

Grade 10

SAFETY: Proper safety measures should be observed at all times.

1. Hand Tools and Bench Work

Threading with taps and dies; types of scrapers and their application; hand reaming; types and use of hand hacksaw blades; filing to size with the object of producing flat and parallel surfaces

2. Layout Work

Preparing metal surfaces for layout; the use of additional layout tools such as a combination set, V-block, steel parallels, surface plate and templates for laying out work from blueprints or drawings

3. Measurement

The construction, care, reading and use of micrometers, vernier calipers, protractors, graduated feed collars and dial indicators; the use of plug, ring, thread and snap gauges

4. Machine Tools, Construction and Operation

(a) Lathe: construction of headstock, carriage and tailstock; centre drilling, drilling in the lathe, cutting speed calculations; machining time calculations; standard tapers, characteristic and use; taper turning attachment, calculations and application; short taper and angle turning using the compound rest; the Unified Screw Thread system and calculations; cutting screw threads; boring in the lathe; reaming in the lathe; the use of lathe mandrels; lathe chuck and face plate work; steady and follower rest applications

(b) Drill press: fractional, letter and number size drills, selection and use; drill holding devices; work holding devices; cutting speed calculations; selection of feeds for drilling; drilling to a depth, reaming; counterboring, countersinking and spot facing; types and use of cutting fluids

(c) Shaper: the internal mechanism of a shaper; setting the length and position of the stroke; the cross feed mechanism; shaping vertical and angular surfaces; sequence of operations for shaping rectangular work; serrating

(d) Horizontal milling machine: changing an arbor and cutter; types of cutters, selection and use; speeds and feeds, simple operations and calculations for the use of the dividing head set; spur gear calculations, depth of cut and selection of cutter; cutting a spur gear

(e) Vertical milling machine: types, sizes and care of vertical milling machines; comparison of horizontal and vertical milling machines; identification of the column, knee, saddle, table, spindle and operating controls; milling a plain surface, milling work surfaces at right angles, milling angular surfaces; the use of collet chucks; selection and use of end mills

(f) Pedestal or bench grinder: grinding of cutting tools; changing, truing and dressing wheels

(g) Surface grinder: types, sizes and care of surface grinders; identification of the main parts such as the wheel spindle, table, cross slide, column and operating controls; safety precautions; grinding wheel components, construction and characteristics; the grinding wheel marking system; grinding wheel types and uses; changing a grinding wheel; truing and dressing a grinding wheel; the care and operation of magnetic chucks and demagnetizing; grinding plain and parallel surfaces to given dimensions

(h) Contour cutting band saw: types, sizes and care of contour metal cutting band saws; identification of the main parts such as the table, upper and lower drive wheels, upper and lower blade guides, blade tension and operating controls; safety precautions; selection and use of blades; elementary sawing operations; welding band saw blades

5. Elementary Metallurgy

The S.A.E. system of classifying steels; shop tests for identifying common metals; physical characteristics and uses of ferrous and non-ferrous metals; hardening and tempering; case hardening methods; normalizing, annealing

6. Hot Metal Work

Forging, drawing and shaping

7. Fasteners

The identification and use of fasteners such as rivets, bolts and nuts, cap screws, set screws, self-tapping screws, flat and lock washers and jam nuts; the identification and use of flat, feather, woodruff and gib head keys

8. Repair and Maintenance

Belts: types, selection, proper operation and repair; power transmission, speed changes; lubrication - bearing types, grease and oil fittings, special lubrication systems

MASONRY

Two-Year Programme Grades 9 and 10

Grade 9

SAFETY: Safe practices and the proper use of tools and equipment should be stressed.

1. Introduction

National Building Code and local by-laws

Use of masonry in construction; bearing and non-bearing walls; properties of masonry materials; advantages and disadvantages of masonry construction

2. Materials Used in Masonry and Concrete Construction

Bricks, blocks, natural and artificial stone, poured and pre-cast concrete

3. Manufacture of Bricks

Materials used, dimensions of bricks, clay terminology, present day methods of brick manufacture

4. Classification of Bricks

Types and their uses; definition of terms e.g. stretcher, header, soldier; nomenclature; quality; coring and frogs

5. Mortar Ingredients

(a) Portland cement: properties, manufacture and storing

(b) Lime: types, properties, manufacture, storing and handling

CAUTION: Unslaked or lump lime is dangerous if not properly handled and is not recommended for student use.

(c) Sand: quality, surface texture, storage

(d) Water: clean and free from foreign matter

6. Mixing Mortar

Ingredients, proportions, water content, fatness and shortness, usable time

7. Brick Work

(a) Bonds: common, English and Flemish bonds and with variations

(b) Brick courses: meaning, dimensions of horizontal and vertical coursing; stretcher, header, soldier and rowlock courses

8. Brick Laying Skills

Soaking lime, screening sand, mixing mortar; stringing mortar; laying bricks to a line, laying between leads; plumbing a stopped end

9. Concrete Blocks

Manufacture: materials used, dimensions and types of concrete blocks; characteristics and application; laying concrete blocks

Grade 10

Note: Reference should be made to the National Building Code and to local building by-laws.

SAFETY: The proper use and care of tools; the necessary precautions for lifting and carrying materials, and using scaffolds, hoists and equipment should be emphasized and reviewed periodically.

1. Mortar

   (a) Properties of hardening; the meaning of cohesion and adhesion; additives; protection from weather

   (b) Cement mortar and lime mortar ingredients; properties and application

2. Mortar Joists

   Characteristics and application of flush, struck, rodded, Vee, raked, beaded, drape and weathered joints

3. Brick Laying

   Layout of brick courses for different bonds; stringing mortar; laying brick courses; the racking of a corner; supporting and setting an arch; laying a rowlock sill; setting out and laying a corbil; planning and laying decorative panels and spandrels

4. Brick Construction

   (a) Walls: bonds and coursing; bearing and non-bearing

   (b) Arches: types and construction

   (c) Piers: bonding and construction of small and large piers

   (d) Chimneys: sizes and application of chimney flue tiles and cleanouts; construction of a typical chimney

   (e) Fireplaces: plans and details; materials used in fireplace construction; construction of a typical fireplace

5. Masonry Blocks

   The manufacture and application of various types of masonry blocks; layout of block courses; bonds and decorative bond work; back-up masonry blocks; relationship between brick and block coursing; damp proof courses; parging and waterproofing

6. Stonework

   (a) Stone: types, characteristics, strength, ease of cutting, water absorption, weathering and erosion, manufacture of artificial stone

(b) Tools: identification and use of stone mason's common tools

(c) Skills: laying out, preparing, setting and pointing of stonework

(d) Bonds: types for rubble and ashlar

(e) Finishes: e.g. hammered, tooled, sawn, polished

7. Concrete

(a) Portland cement: properties, uses in concrete, handling and storing

(b) Aggregate: types, particle size and shape, handling and storing

(c) Proportions for various strengths: quantities of cement, water and aggregate; factors affecting the strength of concrete

(d) Mixing: hand and mechanical mixing, ready-mixed

(e) Placing: form preparation; placing and vibrating concrete

(f) Removing forms: strength requirements of concrete before removal of forms; patching and finishing; curing and hardening

(g) Additives: e.g. colours, accelerators, retarders

(h) Protection from weather and damage; maintaining proper conditions for curing and hardening

(i) Reinforced concrete and concrete for special purposes

PAINTING AND DECORATING

Two-Year Programme Grades 9 and 10

Grade 9

SAFETY: Safe practices in the handling of paints and solvents and the use of ladders and equipment should be emphasized.

1. Introduction

History of painting and decorating; the painter's place in the building trades; qualifications of a good painter

2. Brushes

Types, material, construction and manufacture; bristles; sources (natural and synthetic)

3. Care and Maintenance of Brushes

Breaking in, storage, cleaning, brush suitable for the job, brushing techniques

4. Glossary of Terms

A study of common terminology of materials and techniques used in the trade

5. Value and Uses of Paint

Preservation; decoration and appearance, sanitation; illumination - a modern approach; special uses such as fireproofing

6. Composition and Properties of Paint

Pigments and their sources; vehicles - types, sources and substitutes; driers - types, sources and uses; thinners - types, sources and substitutes

7. Paint Pigments

Natural, chemical and synthetic; sources of white and coloured pigments; purpose and use of extender pigments

8. Vehicles

Linseed oil: manufactured, raw and boiled; uses; other vegetable oils such as tung and nut oil; suitability of mineral, animal and fish oils

9. Driers

Types and sources reviewed, dangers of misuse, oxidation vs. evaporation (correlate with Science)

10. Solvents

True and synthetic; uses and purposes

11. Priming Coats

Importance of proper foundation; purpose and value of priming coat; composition of primer; proper mixing of the prime coat; application - special preparation of wall surfaces - neutralization

12. Undercoat

Purpose and value of a good undercoat; composition and mixture; proper preparation and application - putty and its uses; kinds and types

13. Finish Coat

Kinds and types; the proper finish for the purpose; composition and mixture; importance of proper application

14. Light and Colour

Definition, the spectrum - origin of true colour; refraction, reflection, absorption

15. The Chromatic Wheel

Value and use; primary, secondary and tertiary colours

16. Complements and Their Use

True, split, double, triads, mutual, split mutuals; analogy of colours

17. Colour Values

Hues, tints, shades, tones; colour designing; colour harmony and colour association

18. Freehand Drawing

Highlight, shadow, simple motifs

Grade 10

SAFETY: Safety precautions previously outlined and the use of scaffolds should be stressed and periodically reviewed.

1. Review the Grade 9 course

2. Stains

Sources, natural and synthetic; mixed; proper mixing; purposes and uses; proper application

3. Shellac

Sources, manufacture, solvents; mixtures and cuts - white and orange; purposes and uses; proper application; shellac finishes - French polishes; coloured shellacs

4. Varnish

Composition: gums, solvents, driers. Gums: sources, refining, by-products. Rosin and turpentine: kinds, purposes, uses. Importance of proper application: gloss, flat and rubbed finishes. Exterior and interior uses

5. Stencils

Designing, cutting, application, proper use; decorative value, types

6. Woods and Veneers

Identification of common woods; grain and fibre of hard and soft woods; uses in floors, furniture, trim and construction; veneers and plywoods; origin, composition and use of fillers; preparation for finishing; finishes

7. Wall Coverings

Origin and manufacture; a tour of wallpaper manufacturing plant; types and patterns (straight and drop); wallpaper, cotton, burlap, silk, wood veneers, lincrusta, embossed

8. Hanging Wall Coverings

Preparation of different wall surfaces; measuring and cutting paper; trimming, use of trimmers; folding of paper. Pasting: types, mixtures and composition of adhesive. Hanging: use of chalk lines and other methods used to hang first strip; proper starting place of first strip; techniques of proper application; use of special tools

9. Glazing

Materials: glass, putty, brads; tools; replacing broken lights of glass; preparation of new and old surfaces, proper application

10. Use and care of equipment such as ladders, jacks, drop sheets, blow torch, steam machines, sanders and spray equipment

11. Designing and Building Stage Sets (Optional)

Designing to suit purpose; building, painting, finishing

SERVICE STATION OPERATION

Two-Year Programme Grades 9 and 10

Grade 9

Pupils taking this course should, where possible, be given Business Practice as a related subject in both years.

Topics from the Grade 9 Auto Mechanics Course may be used to supplement the following if time permits.

1. Introduction to shop: safety precautions in regard to toxic and explosive fumes, gases or liquids, lifting equipment, power tools; shop and personal cleanliness; the use of seat and fender covers

2. Names and purposes of common tools used in a service station

3. Lubrication: chassis, types of fittings, threads; methods of applying lubricants, practice in lubricating automobiles; common types of engine oils, gear oils and greases, S.A.E. specifications, detergents in lubricants; changing oil and grease and checking levels

4. Fuels: gasoline, grades and purposes; location of filler cap; diesel fuel, care in handling; action to be taken in case of emergency such as spilling, collision of a vehicle with a fuel pump, etc.; if possible, practice in serving fuels and cleaning windshields, etc., should be given

5. Fastenings: identification of bolts, nuts, cap screws, threads, rivets, washers, cotter pins; their use and application

6. Tires: construction, types, sizes, types of cord, types of rubber, snow tires; practical work in changing, patching and servicing tires

7. Batteries: testing, filling, charging batteries; grades of batteries and reason for price variations; practical work in charging and servicing batteries

8. Washing and polishing: methods of washing, detergents and cleaning compounds; polishes, types, methods of application; practice in washing and polishing

9. Cooling system: liquids used in cooling systems; testing anti-freeze; replacing hose connections and fan belt; practical work in servicing cooling systems

10. Public relations: merchandising, inventories

Grade 10

Topics selected from the Grade 10 Auto Mechanics course may be used to supplement the following topics if time permits.

1. Safety: review of safety precautions in regard to toxic and explosive fumes, gases, liquids, lifting equipment, power tools, etc.; stress the importance of personal cleanliness and good housekeeping in the shop and the use of seat and fender covers
2. Chassis units: names and location of units; purpose of major units and their special lubrication
3. Tools: names, purposes and care of special tools used in service station work; maintenance and repair; instruction on some power equipment
4. Lubrication: details of checking and lubricating various types of power units on modern cars; details of S.A.E. lubricants and additives used by the manufacturer and those sold by other than oil companies; lubricating and adjusting front wheels
5. Fuels: further precautions in handling; storage problems; insurance underwriters safety requirements
6. Electrical system: names of units; the wiring connections and wire sizes used in lighting and ignition circuits; lamps and sealed beam units; fuses and relays; spark plug sizes, heat range, cleaning, spacing and testing; changing batteries and cables
7. Fastening: familiarization with more threaded parts such as machine and metal screws
8. Running Gear
   - (a) Front wheel suspension systems - enough theory to enable pupils to recognize faults or worn parts
   - (b) Wheel angles - the names of the wheel angles, checking toe-in
   - (c) Wheel balancing
   - (d) Checking brake lining and master cylinder level
9. Body work: replacing chrome trim, touch up paint jobs, types of paint, types of rubbing compounds, the use of fibre glass and plastics in small repairs
10. Cooling system: cleaning compounds, precautions, flushing the cooling system, replacing expansion plugs, installing block heaters; pressure systems and pressure caps; diagnosing minor troubles, locating leaks
11. Correction of exhaust system troubles, e.g. replacement of defective units, gaskets and brackets, alignment of exhaust system
12. Further work on public relations, merchandising, inventories, estimating, making out invoices, receipts, etc.

SHEET METAL

Two-Year Programme Grades 9 and 10

Grade 9

SAFETY: Safe practices should be emphasized regarding the handling of materials and the use, care and maintenance of all tools and equipment.

1. Materials

   (a) Common sheet metals - (e.g. galvanized iron, tin plate, cold rolled steel, aluminum)

      Description and uses
      Advantages and disadvantages of each
      Standard sheet sizes and gauges for ferrous and non-ferrous metals
      Methods of manufacture

   (b) Soft solders: compositions; melting temperatures; uses

   (c) Soldering fluxes - (e.g. muriatic acid, zinc chloride, sal ammoniac, rosin, soldering paste and phosphoric acid): composition of fluxes; corrosive and non-corrosive types; purposes and uses of fluxes and dip solution; methods and reasons for defluxing after soldering; handling of acids

   (d) Metal fasteners

      Tinners' rivets: weights and sizes
      Sheet metal screws (sizes and drill sizes)

   (e) Wire

      Coatings
      Gauges and uses

2. Measurement and Layout

   (a) Use of squaring, measuring and marking tools

   (b) Types of lines and common angles

   (c) Scale drawings of patterns

   (d) Plane surfaces, e.g. circles and regular polygons

   (e) Laying out from a working edge and a centre line

   (f) Templates and their use

   (g) Working drawings (orthographic projection)

   (h) Notches and their uses

   (i) Seam and reinforcement edge allowances

3. Machine Processes (Machines and Operations)

   (a) Adjustable bar folder: main parts, capacity, safety precautions; setting and locking gauge; use of stops for various angles; types of folds, e.g. single hem, open and double closed folds

   (b) Box and pan brake: main parts; capacity, safety precautions; adjustments of fingers

   (c) Foot operated squaring shear: main parts, capacity, safety precautions; use of gauges (side, back and front); securing a working edge; cutting on a line

   (d) Slip roll forming machine: main parts, capacity, safety precautions; breaking in material; feeding material between rollers; adjusting tension of rollers; forming cylindrical objects

   (e) Standard hand brake: main parts, capacity, safety precautions; straight bending; forming a Pittsburgh lock

   (f) Drill press: operating procedure

4. Hand Processes (Tools and Operations)

   (a) Bench stakes: description, name and uses

   (b) Cutting and notching: use of straight, curved, aviation and combination snips; use of side-cutting pliers and wirecutters

   (c) Hand lever punch: main parts, capacity, changing punches and dies, uses

   (d) Soldering: weights, sizes and purpose of soldering coppers; conductivity of copper; oxidation; capillary action; tinning a soldering iron; soldering a lap seam

   (e) Grooving: grooved seam allowances; use and selection of hand groovers; completion of grooved seam; button punching

   (f) Riveting: spacing, punching or drilling rivet holes; use of rivet set

   (g) Wiring: wired edge allowances; preparatory folds; forming wire; completion of wired edges

Grade 10

SAFETY: Safe practices should be emphasized regarding the handling of materials and the use, care and maintenance of all tools and equipment.

1. Materials

(a) Common sheet metals: common properties - tenacity, malleability, conductivity, ductility, specific gravity, metallic lustre and fusibility of such metals as galvanized iron, tin plate, cold rolled steel, aluminum and copper; methods of manufacture; approximate costs

(b) Fluxes: types, applications, preparation of fluxes for various metals

(c) Metal fasteners: tinner's, pop and aluminum rivets; sheet metal screws; machine bolts and nuts; hinges, catches, hasps and staples

2. Measurement and Layout

(a) Geometric problems: erection of perpendiculars, bisection of angles and arcs, construction of regular polygons

(b) Mechanical Drafting: working drawings (orthographic projection) freehand sketching of isometric and oblique pictorial views

(c) Laying out: transferring dimensions from a drawing to the sheet metal; use of indentations for locating bending lines; procedures for determining circumferences of circles mathematically; step-off method and circumference rule; perimeters, areas; adding seam allowances for double, grooved, riveted, soldered and Pittsburgh lock seams; drive and "S" cleats

3. Pattern Development

Note: Scale drawings should be made of all articles; all patterns developed should be regular trade size and fabricated in metal.

(a) Parallel line method: the principles of parallel line development; developments such as two and three piece round elbows, square elbows, rectangular offsets, 90° and 45° T joints (equal and unequal diameters); trough mitres

(b) Radial line method: the principles of radial line development; developments such as right cones (frustums and truncated cones), square and hexagonal pyramids (frustums and truncated pyramids); funnels, rain curtains, pitched covers, measures and tapered pails

(c) Triangulation method: the principles of triangulation; developments such as pitched covers, rectangular tapers and hoods, round tapers, square to round transitions (symmetrical)

4. Hand Process (Tools and Operations)

(a) Cutting: use of aviation, scroll, straight and curved snips

(b) Folding and forming: use and recognition of bench stakes and improvised stakes in forming cylindrical and conical-shaped articles

(c) Riveting: blind riveting; pop riveting; use of cranked pliers; use of aluminum, brass and steel rivets

(d) Soldering: selection of soldering iron, selection of proper flux, tinning metals in preparation for soldering; soldering dissimilar metals; proper application of solder to various types of seams e.g. overhead, vertical, riveted and grooved

(e) Double and bottom seaming: metal allowances required, preparatory folds, method of turning seam with mallet; drawing metal back from folds; squaring and tightening seam in both rectangular and cylindrical objects

(f) Drive and "S" cleats: uses and method of forming

5. Machine Processes (Machines and Operations)

(a) Continued use of squaring shears, bar folder, hand brake, box and pan brake for further fabrication

(b) Slip roll former: cylinders and conical shaped articles; wire; wired edges

(c) Lockformer: capacity; attachments; forming Pittsburgh lock and flange

(d) Bar and tube bender: setting up and forming heavy wire, bar and rod

(e) Circle shears: cutting discs and straight slitting

(f) Unishear: cutting patterns

(g) Rotary machines: basic operations involved with the turning, edging, wiring, crimping, beading and easy edger machines

(h) Spot welder: care and safety precautions, types and capacity of machines, setting up and changing tips, controls and their functions, practice in operation

6. Shop Maintenance

Care of hand tools, sharpening; oiling; painting and maintenance of bench and floor machines

7. Air Conditioning

History of heating; basic elements of a heating system; furnace accessories (blowers, humidifiers, filters); registers, grilles, diffusers; choice of fuels; fuel burners; types of warm air heating systems; maximum economy of fuels; determining the heating load; balancing warm air systems; summer air conditioning

- (c) Pumps: impeller and rotor types
- (d) Forced air system
- (e) Trouble prevention and maintenance

8. Fuels and Fuel Systems
    - (a) Handling and storing fuels; precautions
    - (b) Gravity system
    - (c) Pressure differential and how obtained in the two-and four-stroke cycle engine
    - (d) Pumps: types and operation
    - (e) Fuel induction: two-and four-stroke cycle engines
    - (f) Basic principles of carburetion
    - (g) Tank construction
    - (h) Carbon monoxide gas: dangers and precautions
    - (i) Air cleaners: types and purposes
9. Ignition Systems
    - (a) Fundamentals of electricity
    - (b) Current flow - Ohm's Law
    - (c) Magnetism and electro-magnetism
    - (d) Electro-magnetic induction
    - (e) Spark plugs: heat range, selection and service
    - (f) Application of the above in battery ignition systems and in magnetos
10. Use and selection of hand tools
11. The dismantling and assembling of an engine to become familiar with the relationship of the various units

Grade 10

SAFETY: Review of safety precautions outlined in Grade 9.

1. Engine trouble diagnosis

2. Engine: repair and maintenance including the full use of manufacturer's manuals

   (a) Proper dis-assembly instructions to include handling, cleaning and marking mating parts

   (b) Measurement of parts to determine wear

   (c) Fits and clearances - necessity for accuracy

   (d) Corrective measures to meet the manufacturer's standards as specified in manuals

   (e) Assembly according to manufacturer's standards, e.g. proper torques and lubrication of parts and seals. This will require instruction in the use and care of special tools and equipment

   (f) Oil seals and gasket installations

   (g) Governor: operation and adjustment

   (h) Manual starting equipment and installation

   (i) Testing for overall speed range, operation and power, including use of test equipment

3. Lubrication

   Properties, identification, selection and application of lubricants

4. Cooling

   Diagnosis and study of overheating and underheating problems; corrective measures, e.g. pump rebuilding; study of corrosion, causes and prevention

5. Fuel Systems

   (a) Properties of engine fuels and the conversion of fuel to mechanical energy; vapourization to achieve combustion; combustion and its by-products; simple carburetion to include gasoline-air ratios, venturi action and carburetor circuits; modern carburetion including gasoline filters; carburetor dis-assembly, proper cleaning and examination of parts and their relation to each other; carburetor assembly; carburetor installation and adjustment; air cleaners, service and installation

   (b) Fuel pumps: diagnosis of troubles; corrective measures including complete rebuilding of pump

   (c) Tank operation and construction

6. Batteries: construction, selection, care and testing

7. Ignition
    - (a) A review of magnetism and electromagnetism
    - (b) The production of high voltage by induction
    - (c) The principle, construction and operation of magnetos
    - (d) Operation and construction details of battery coil ignition units
    - (e) Adjustments, e.g. point adjustment
    - (f) Ignition timing including the use of special equipment
8. Charging systems: their operation and circuits
9. Starting systems: types, operation and installation
10. Starting the engine: safe procedures should be stressed
11. Engine Tune-up
    - (a) Special tools and equipment
    - (b) Procedure
    - (c) Practical application
    - (d) Trouble shooting: correct procedure and application
12. Special drives, gear trains, simple transmission and lower units; operation, assembly and service
13. Parts
    - (a) Reporting on the parts required by the description, part number and cost
    - (b) Explanation of parts warranty
14. Storage

Storage precautions, e.g. right way up, drainage, use of inhibitor oils; out of season storage, carrying out of manufacturers' recommendations

WELDING - ELECTRIC ARC

Two-Year Programme Grades 9 and 10

Grade 9

Note: If the pupils have not been previously instructed on the safety precautions and operation of oxy-acetylene equipment thorough instruction should be given.

SAFETY: The pupils should be made familiar with the shop routine and the safe operation of all the equipment.

1. Introduction

Definition and history of arc welding; inspection of arc welding machines in school shop; demonstration of arc welding

2. Welding Equipment

(a) Hoods: method of inserting clear and coloured glass; shades of lenses; materials used for helmets

(b) Cables: ground and electrode connections and methods of securing

(c) Holders: different types and sizes

3. Energy Supply

Types of arc welding machines; simplified explanation of current, voltage, and their relation to good welding; simple welding circuit

4. Fundamentals of Welding

Striking an arc by scratching and tapping; electrode angle, sound of arc, speed of travel, formation of the crater, frozen electrode, arc length; magnetic arc blow; types of weave motions and need for uniformity and appearance

5. Electrodes

A study of E6012, E6013 and E6014 electrodes; colour identification; power supply

PRACTICAL WORK

1. Welding Operations

Note: Stress the use of the welder's chipping hammer and wire brush to clean all deposits

(a) Inserting clear and coloured glass in helmets in proper locations

(b) Securing ground and electrode connections; adjusting current of welding machine; checking main power switch

(c) Striking arc and running parallel stringer beads on mild steel plate from left to right. Use 1/8" and 5/32" straight polarity electrodes (Point out need for penetration and fusion) Repeat from right to left

(d) Repeat the exercises using 1/8" and 5/32" reverse polarity electrodes

(e) Running parallel beads using crescent weave motions on mild steel plate Use both types and diameters of electrodes in (d) above

(f) Running beads with 1/8" and 5/32" diameter iron powder electrodes

(g) Joining beads of straight and reverse polarity electrodes

(h) The use of machinist's hammer, centre punch, scribers, dividers and square

(i) Have students lay out straight lines and circles on mild steel plate with the use of soapstone

2. Cutting Exercises

Note: If it is necessary for the students to cut their plates for their practice exercises by means of the hand cutting torch, all safety precautions should be reviewed.

Grade 10

1. A review of safety precautions and basic fundamentals of the Grade 9 programme

2. Technique for Joining Beads

Starting position of the electrode, change in angle and height of the electrode when joining previous beads, defects caused by poor joining procedures

3. Comparison Between Shielded and Unshielded Electrodes

Characteristics of bare, thinly and heavily coated electrodes (standard types); iron powder electrodes; A.W.S. classification system; method of selecting proper electrodes

4. Elementary Expansion and Contraction

Common effects of weld contraction; methods used to counteract distortion; applications of pre-heating, post-heating and stress relieving

5. Fillet Welding

Definition of a fillet weld, parts of a fillet weld, convex and concave welds, defects in the welds; method of determining the size of a fillet weld by the use of a gauge

6. Identification of Ferrous and Non-Ferrous Metals

Spark test for low carbon steel, high carbon steel and cast iron; fracture test, grain structure; colour test; chip test, characteristics of the chips; colour test of copper, bronze and brass

7. Basic Joint Design for Arc Welding

   Types of butt, lap, corner, edge and tee joints; application of welded joints; use of fillet welds

8. Using Oxy-Acetylene Cutting Equipment in Arc Welding

   (a) Use of the cutting torch for beveling edges

   (b) Piercing holes and circle cutting

   (c) Layout of shapes using templets

9. Machine Gas Cutting

   Note: Refer to item 3 Oxy-Acetylene Welding course, Grade 10 of the Four-Year Programme

10. Manufacture of Iron and Steel

    Note: Refer to item 6 Oxy-Acetylene Welding course, Grade 10 of the Four-Year Programme

11. Arc Welding Machines

    Direct current welding generators; A.C. welding transformers; combination A.C. - D.C. transformer - rectifier units; methods of adjusting arc welding machines

12. Cutting Metals with the Electric Arc

    Carbon arc cutting; use of metallic electrodes for cutting; piercing holes; cutting cast iron with the electric arc

13. Cast Iron

    Types of cast iron; techniques when arc welding cast iron; electrodes for cast iron arc welding

14. Horizontal, Vertical, Up and Down and Overhead Arc Welding

    Preparation and positioning of plates; manipulation of electrodes; location of the beads

PRACTICAL WORK

1. Welding Operations

   (a) Preparing and welding an edge joint on ¼" mild steel plate with 1/8" standard electrodes

   (b) Preparing and welding a lap joint and a flush tee joint on the same size of plate as in (a) above using 5/32" diameter E6014 electrodes

   (c) Making a two and a three pass fillet tee weld on ¼" plate using 5/32" electrodes

   (d) Join a circular pipe to a flat plate with 5/32" E6014 electrodes

(e) Pad a plate running at least two layers of weld metal using standard electrodes

(f) Build up a worn shaft by applying padding procedures

(g) Practice good tacking and intermittent welds on tee joints

(h) Preparing and welding a square butt joint on 3/8" mild steel plate using a backing strip and 5/32" reverse polarity electrodes

(i) Preparing and welding a single V butt joint with and then without a backing strip. Same size plate and electrodes as in (h) above

(j) Running downhand vertical beads using 11 gauge mild steel and 1/8" electrodes

(k) Running parallel beads on ¼" mild steel plate in the horizontal position using 1/8" electrodes

(l) Preparing and welding a lap, tee and a butt joint in the horizontal position

(m) Running beads in the vertical up and down positions

(n) Cutting cast iron by means of the electric arc

(o) Welding cast iron using ferrous and non-ferrous electrodes

(p) Select some type of project that has to be assembled and welded by electric arc welding

WELDING - OXY-ACETYLENE

Two-Year Programme Grades 9 and 10

Grade 9

SAFETY: The oxygen and acetylene gases used in this type of Welding may be supplied by a manifold or cylinder system. The student should be made familiar with shop routine and safe operation of each type of equipment.

1. The Development of Oxy-Acetylene Welding

Definition and history of oxy-acetylene welding; the introduction of the first acetylene welding torch; the importance of oxygen and acetylene gas in the flame; properties and methods of manufacturing oxygen and acetylene; the proper ratio of oxygen and acetylene to produce good combustion

2. Equipment

(a) Introduction of the pupil to oxy-acetylene equipment in the school shop

(b) Discussion of colour standards, fittings and threads, safety rules pertaining to the handling of gas equipment, eye protection, protective clothing, tools

(c) Cylinders: construction of commercial cylinders, modern use of liquid oxygen; safety features and methods of testing for leaks in oxygen and acetylene cylinders, hose and torch connections

(d) Pressure regulators: types, function (tracing path of gases from cylinders through the regulators to lines); the function of the diaphragm, adjusting screw, tension spring, pressure gauge; causes of a creeping regulator; safety devices - colour, nuts, threads; rules for avoiding damage to regulator

(e) Welding torches: types, function, mixing head and interchangeable tip system, care of torch and tips, safety in handling torches

3. Types of Welding Flames

(a) Carburizing, neutral - oxidizing; temperatures and their effect on metal

(b) Flashback and backfire: comparison of flashback and backfire; causes and remedy; safety rules

4. Basic Joints

Types, proper alignment, method of tacking, selection of tip for type of joint being welded, shop methods of testing joints, the cause of common welding defects such as undercut, adhesion, poor penetration, lack of fusion, porosity

5. Filler Rods

Selection of types and sizes for mild steel only

6. Introduction to Oxy-Acetylene Cutting Process

Elementary explanation of oxy-acetylene cutting; brief description of the cutting torch; method used for cutting a straight line on mild steel plate using the freehand technique

PRACTICAL WORK

1. Welding Operations

(a) Use of proper wrenches on welding fittings

(b) Assembling oxy-acetylene equipment: hose-lines, regulator, torch

(c) Opening up and closing down oxy-acetylene equipment

(d) Lighting the torch; producing the three types of flames and observing their effect on mild steel plate

(e) The use of machinist's hammer, centre punch, scribers, dividers, square

(f) Method of laying out straight lines using soapstone

(g) Running lines of fusion on mild steel plate without filler rod and with filler rod

(h) Running weave motions on mild steel plate with filler rod

(i) Preparing and welding a corner joint without and then with filler rod

(j) Preparing and welding a plain open butt joint using 3/32" diameter filler rod

(k) Preparing and welding an open corner joint on 11 ga. sheet steel plate

2. Practical Cutting Operations

Hand cutting straight lines on ¼" steel plate; use of soapstone, ruler and centre punch to obtain more accurate cuts

Grade 10

SAFETY: Review the safety precautions previously outlined.

1. A review of the essential topics and practical exercises of the Grade 9 course

2. Oxy-Acetylene Cutting

Theory of cutting; the oxy-acetylene cutting blow-torch, internal structure and function of the parts; selection of cutting tip sizes and gas pressures, cutting attachment for combination cutting and welding torch; using the radius bar for hand cutting; piercing holes and circle cutting; straight line and bevel cutting; common cutting faults

3. Machine Gas Cutting

Structure and function of a cutting machine; use of a chart to select cutting tips and gas pressures; procedures when bevel cutting and radius cutting with portable cutting machine

4. Steel

Production of steel; low carbon, medium carbon and high carbon steels; alloy steel; stainless steels; effects of carbon when welding steel

5. Sheet Metal Welding

Sheet metal gauge, United States Standard; tack welding, size, spacing and strength of tack welds

6. Fusion Welding of Heavy Gauge Steel Plate

Preparation of edges when welding heavy steel plate; forehand and backhand method of welding; wash welds

7. Expansion and Contraction

Effects of expansion and contraction in welded joints; controlling the effects of expansion and contraction; pre-heating and post-heating when making welded joints; linear expansion per foot of common metals

8. Fusion Welding of Cast Iron

Production of cast iron; types of cast iron; malleable castings; preparation of cast iron for oxy-acetylene welding; pre-heating and post-heating; welding techniques; use of flux; cast iron welding rods, composition and sizes

9. Bronze Welding or Brazing

Theory of bronze welding - development from Speltzer brazing; applications of bronze welding; technique of bronze welding, necessity for proper cleaning, proper heating, good tinning and the use of flux when bronze welding; bronze welding rods and their uses, melting points and sizes; brazing steel; brazing cast iron; galvanized iron - effect of galvanized coatings, preparing galvanized parts for brazing; building up missing parts with bronze, use of carbon rods or blocks and carbon paste

10. Silver Brazing

Application of silver brazing; silver brazing materials; colour, melting points and uses; preparation of parts for silver brazing; use of flux when silver brazing; techniques for making silver brazed joints; use of air - acetylene torches and propane gas blow-torches

11. General Application of Oxy-Acetylene Welding (Optional)

Machine, automotive (body and fender) and farm equipment repairs

Note: The instructor may select from Section 11, activities related to the local community. For example, in a farming area, the applications might apply to farm machinery.

PRACTICAL WORK

1. **Welding Operations**

   (a) Preparing and welding a butt joint on 11 ga. sheet iron with 1/8" filler rod

   (b) Preparing and welding a lap joint and a tee joint on 11 ga. sheet iron using 3/32" diameter mild steel filler rod

   (c) Preparing and welding single Vee butt joint on ¼" plate using forehand technique - flat position. Repeat using backhand technique

   (d) Vertical welding butt, corner and Tee joints on 11 ga. sheet iron with 1/8" filler rod

   (e) Brazing: making a butt and lap joint in the flat position using 1/16" material; welding a butt joint in the flat and vertical position on 1/8" steel plate; making a lap joint in the vertical position using 1/8" steel plate; welding a butt joint in the horizontal position using 1/8" steel plate; bronze welding of cast iron using 1/8" filler rod

2. **Cutting**

   Making straight line cuts and bevel cuts using a guide bar; straight line and bevel cutting using gas cutting machine; cutting circles to a given diameter

3. **Optional**

   (a) Brazing stainless steel - butt, lap and corner joints

   (b) Welding stainless steel - butt, lap and corner joints

   (c) Developing projects for welded fabrication

MATHEMATICS

Four-Year Programme

The Science, Technology, and Trades Branch

General Observations

1. Suggested outlines of the work to be followed in the various grades are provided below, but these may be changed or supplemented where necessary to meet local requirements.

2. The courses are based on five periods of forty minutes duration per week. To permit some selection, more topics have been included than can normally be covered in this time.

3. It is expected that the items designated in the courses as "optional" will be included in the work taken with above-average classes, or in the assignments given to the better students within a class group of varying ability.

4. In planning the courses for Grades 11 and 12, consideration has been given to the fact that most of the pupils from the Technical Course go directly to industry. However, some pupils do proceed with advanced technological training and therefore some consideration has been given to the needs of these pupils. In most cases, the practical applications of theoretical topics have been shown, although it is believed that some mathematics may be taught for the development of mathematical skill alone. Some topics should provide for necessary drill while others are included to supply practice in methodical arrangement of work which will lead to logical reasoning.

Aims of the Courses

1. To give a good basic training to those pupils who leave school at the end of Grade 10 or Grade 12 respectively as well as those who will continue their formal education.

2. To stress the fundamentals of Mathematics so that the student will be able to solve normal mathematical problems arising in the shops or in a practical field of work.

3. To motivate the student by correlating the content of the course with related subjects where possible and also by correlating related phases of Mathematics.

4. To provide training in citizenship, one of the important phases of education, by developing habits of thought such as sound reasoning, clear thinking, use of judgment, powers of concentration, and by developing work habits such as neatness, accuracy, initiative, perseverence, self-reliance.

Grade 10

1. Mensuration and Arithmetic

The necessity for repeated drills in fundamental operations, if those skills are to be maintained and improved, is recognized. It is felt that mental or mechanical drill in Arithmetic might be taken in some periods. As far as possible, topics should be reviewed or taught through shop problems. The pupils should receive much drill in the use of the decimal equivalent tables.

Arithmetic

Addition, subtraction, multiplication, and division of fractions through shop problems; practice in such operations as $\frac{47}{64} = \frac{3}{4} - \frac{1}{64}$ and similar examples; nearest ruler fraction

Addition, subtraction, multiplication, and division of decimals; conversion of decimals to fractions and fractions to decimals; use of the table of decimal equivalents particularly with reference to the 64th scale; significant digits and the correct rounding off of decimals

Use of the micrometer; mathematics of the scale, reading the scale, making of settings

Use of the Vernier: 1000th scale

Per cent and per cent error

Circular mil calculations

Measurement of Length

Calculation of perimeters of: square (4s); rectangle 2(l + w); triangle (a + b + c) circle (πd or $2\pi r$); the value for π to be in accordance with the degree of accuracy required; cutting and surface speeds, feed of lathe and drills

Measurement of Area

Formulae to be developed or illustrated where possible. Efforts should be made to use practical shop problems in this work.

Area of the square (s^2); formal method of square root in finding the side of a square from the area; the right-angled triangle and the relationship between the sides. Area of a rectangle (lw) extended to areas of various rectangular surfaces, use of square root in finding the length of diagonals; area of the parallelogram and the rhombus; area of the triangle; areas of triangular surfaces such as floors, fields, lots; use of the formulae:
$A = \frac{1}{2}bh$

$A = \sqrt{s\ (s - a)\ (s - b)\ (s - c)}$;

Area of the equilateral triangle, $A = .433s^2$;

Applications to the altitude of sharp V thread and the hexagon; area of the trapezium; areas of figures combining areas of a triangle and a rectangle or a triangle and a trapezium such as gables, templates; area of a circle, $A = \pi r^2$ or $.7854D^2$, extended to capacity of pipes; pressure in cylinders; use of the formula $d^2 = D_1^2 + D_2^2 + D_3^2$ to find the diameter of a pipe equal in capacity to several pipes; areas of combined figures

Optional Topics

Area of the surface of rectangular objects; lateral area = ph; area of walls, lateral area of buildings

Area of the surface of a cylinder (ch); finding the number of square feet of metal in cylindrical tanks, pipes, and cans

Volume

The table of cubic measure (common units)

The volume of rectangular and triangular forms and structures with uniform cross-section throughout; such as, tanks, reservoirs, and excavations

The volume of cylinders (πr^2h or $.7854\ D^2h$): finding capacity of cylindrical tanks

Board measure: meaning of, units of measurements, calculations

2. Geometry

Points and Lines: review Grade 9 work; practice in measuring, estimating, and constructing lines using English and metric units

Angles: review Grade 9 work; practice in measuring, estimating, constructing angles; relationships between units; changing 3.5° to $3^\circ 30'$, etc.

Types of angles: acute, right, obtuse, straight, reflex, complementary, supplementary

Uses in some of the following: latitude, longitude, standard time, rotation, direction, mariner's compass, (32 points), bearings, surveyor's measure, gear teeth, taper, motor-timing, and threads

Experimental determination of the relationships between vertically opposite angles, the sum of the angles in a triangle, exterior and interior, non-adjacent angles

Numerical applications

Triangles: construction and comparison of triangles to show congruency in the four cases—three sides, two sides and contained angle, two angles and corresponding side, hypotenuse and one side; classification according to sides and angles; special study of the properties of isosceles and equilateral triangles; study of two isosceles triangles on opposite sides of a common base to lead up to accurate construction

Accurate Constructions; review and extension of the work of Grade 9

The following constructions: Bisecting a given line; constructing right bisector; illustration by measurement—line joining mid-points of sides of a triangle = ½ base; right bisector of a straight line is the locus of centres of circles passing through the ends of the straight line; family of circles through two given points; circumcentre and circumcircle in acute, obtuse, and right-angled triangles; medians; centroid divides median in ratio of 1:2; illustration of centre of gravity by cut-out triangle in cardboard, sheet metal, or plastic

Bisecting a given angle: constructing bisectors of several angles of increasing size to develop method of drawing a perpendicular from a point inside a line; constructing special angles by bisections from 90° and 60°; bisecting the three angles of a triangle to show that the bisectors are concurrent

Constructing a perpendicular from a point outside a line: distance from a point to a line; altitude of a triangle; the orthocentre; any point of the bisector of an angle is equidistant from the arms of the angle; constructing a family of circles to touch the arms of an angle; inscribing circles in all types of triangles; escribed circles

Constructing an angle equal to a given angle using ruler and compasses only; constructing equiangular triangles and quadrilaterals

Parallel lines: the relationships of angles formed by a transversal; parallelograms and related facts by measurement; rhombus—diagonals bisect each other at right angles; dividing a line into equal parts and in given ratio

Regular polygons: construction of equilateral triangle, square, hexagon (circle method), octagon by 45° angle at centre of circle and from a square (half diagonal method), any polygon by use of angle at centre; sum of angles of polygon; the angles of a regular polygon

Circle: locating centre of circle by bisecting chords; equal chords; angle in segment and in semi-circle; tangent properties; belts and pulleys

The right-angled triangle: the Pythagorean law by measurement of squares; calculation of sides of right-angled triangles; whether given sides form a right-angled triangle

3. Ratio and Proportion

A study of simple ratios between measures, such as weights, volumes, distances, etc.

Scale drawing: similar triangles; ratios of corresponding sides; numerical problems; discovery, by measurement and calculation, that the ratio of pairs of sides in right-angled triangles is constant for a given angle

4. Algebra

Review of algebraic notation and of the four fundamental operations

Review of solutions of equations of the first degree in one unknown. Examples with integral, fractional, and decimal coefficients; graded problems requiring the solution of these equations

Review and extension of factoring to include the following types: polynomials in which a common factor is obtained by inspection or by grouping of terms; trinomials with binomial factors; perfect square; difference of squares; polynomials which reduce to the difference of squares on completing a square

Algebra applied to formulae from the shops: tapers; threads; pulleys and simple gear trains; gear calculations (using given formulae); resistances in series and parallel

5. Trigonometry (optional)

An introduction

Grade 11

1. Index Laws

Extension to include fractional, zero and negative indices; use of standard form to express very large or very small numbers to required degree of approximation; operations with standard numbers

2. Logarithms

Definition of a logarithm; use of logarithmic tables; use of logarithms for multiplication, division, powers, and roots; problems, mensuration, formulae, etc.; use of logarithmic calculation to facilitate solving these problems

3. Slide Rule

(a) Simple operations of multiplication, division, powers, roots

(b) Combined operations: use of slide rule for computations involved in solutions of problems of mensuration, ratio, proportion, etc.

4. Mensuration

Development and algebraic manipulation of formulae along with the practical use of formulae. Facility in the use of the slide rule can be developed by using it to check answers in this section

A. Surface Measurement

Review perimeters and areas of rectilinear, triangular and circular figures through practical problems and the manipulation of formulae; review the right triangle

Areas: the circular sector; the circular ring; the segment of a circle; the curved surface of a cylinder

Lateral and total surface area of a cone; lateral area of a frustum of a cone; the surface area of a sphere; perimeter and area of an ellipse; areas of regular polygons, finding the side of a regular polygon; lateral surface area of a pyramid and the frustum of a pyramid

B. Measurement of Volume

Review of underlying principles and calculation of volume of prisms and cylinders

Solution of practical problems based on prisms such as tanks, cylinders, castings, foundation walls, etc.; use of tables of density to determine weights; expressing volumes in various units of capacity; volume of cones, spheres, pyramids, castings; the solving of formulae for any one measurement; content of a partly-filled tank; volume of a frustum of a cone; problems on areas and volumes

5. Trigonometry

Introduction: practical use in mathematics of navigation, surveying, machine design, and other fields

The Right-Angled Triangle

The functions of the angles: sine, cosine, tangent; practice in writing the ratios for right-angled triangles of given dimensions; construction of right triangles to determine ratios for given angles and to determine angles having a given ratio; use of simplified tables; use of the unit circle to show variation in values from 0° to 90° for the different functions; simple problems involving the calculation of unknown distances or angles

6. Algebra

A. Review

Fundamental operations including the laws of signs and exponents; simple equations with decimals and fractions involving transposition, cross multiplication and clearing of decimals and fractions; applications to Pythagorean theorem and practical problems

B. Simultaneous Linear Equations

Graphical solution; elimination by substitution; elimination by addition or subtraction; applications to practical problems with two unknowns

C. Multiplication and Factoring

Multiplication and squaring of binomials extended to include trinomials; type products; factoring; (common factor) grouping, a perfect square, the difference of two squares, trinomials, incomplete squares, factor theorem, sum and difference of cubes

D. Ratio and Proportion

Direct and joint variation

7. Synthetic Geometry (optional)

Note: Some work on formal proofs might be done at this stage

A. The Circle

Definition and meaning of the terms related to the circle: sector, segment, arc, semi-circle, tangent, secant, concentric circle, the locus

To draw a circle through three points; to find the centre of a circle, given an arc; to circumscribe a circle about a triangle, and vice versa; to inscribe a circle in a triangle, and vice versa; to compare angles in a circle; to inscribe a circle inside or outside of a regular polygon; to draw a direct common tangent, and a transverse common tangent to two given circles; to draw circles tangent to lines and circles

The application of the above to practical problems

B. Areas of Similar Figures

To construct: a parallelogram equal in area to a triangle; a triangle equal in area to a trapezium, pentagon, etc.; a square equal in area to the sum of three squares; to divide geometric figures into any number of equal parts

The application of the above in designs of mosaics, crests, posters, etc.

Grade 12

The selection and the order of the topics should be chosen to suit the local requirements.

1. Algebra

A. Review of Grade 11 Algebra; operations with fractions; fractional equations

B. Simple Surds

Mixed and entire; addition of like surds; multiplication and division; tables of approximate values; rationalizing the denominator

C. Quadratic Equations

Solving by: graphic method; factoring method; completing the square; quadratic formula; theory of quadratics

Applications to Pythagorean theorem and problems relating to machine shop and tool and die design, involving the right triangle

D. Quadratic Equations in two unknowns; surd equations

E. Series

Arithmetic and geometric series (optional)

2. Trigonometry

A. The Right-Angled Triangle

Review simple trigonometry (Grade 11)

Reciprocal ratios: cotangent; secant and cosecant; use of tables; ratios of common angles e.g. 30°, 45°, and 60°, complementary ratios; limit ratios; simple basic formulae: e.g. $\tan x^\circ = \frac{\sin x^\circ}{\cos x^\circ}$

General review: practical problems involving the right triangle pertaining to gauges; V-blocks, dovetail sections; die sections and die punches, etc.

B. Angles greater than a right angle

Quadrants and co-ordinates

Definitions; changes in the signs of the functions for the quadrants; simple rules for finding the ratios of angles betwen 90° and 360°; drawing the graphs of $\sin x^\circ$ and $\cos x^\circ$ for values of x° from 0° to 360°; alternating currents; finding an angle when a function is given; graphs of curves of trigonometric functions

C. Logarithms

Logarithms of trigonometric functions; use of log tables in trigonometric calculations

D. The Oblique Triangle

The law of sines, the cases, solution of the oblique triangle; the law of cosines, the cases, solution of the oblique triangle; cotangent formula for heights; applications to problems on distances, navigation, framework, surveying

E. Areas

Triangles, two sides and included angle, one side and two angles, three sides; parallelogram, two sides and included angle

F. Half-Angle Formulae and Tangents

Radii of inscribed and circumscribed circle, half-angle formulae, law of tangents; solution of triangles and practical problems

3. Business Mathematics (optional)

Some of the practical applications of per cents, income tax, profit and loss, trade discount, simple interest, instalment buying, property insurance and taxes

4. Statics

A. Force, moments, centre of gravity, friction

Vectors, gravity, Newton's law of gravitation, weight; the lever, resultant of two parallel forces; calculation of centre of gravity of various solids; laws of friction, coefficients of starting and sliding friction, advantages and disadvantages; normal reaction and total reaction of surfaces

B. Machines

Velocity ratio, and mechanical advantage, the six mechanical powers, levers of three classes, the pulley, the inclined plane, the screw, the wheel and axle, the wedge, and trains of gears

C. Conditions of equilibrium of forces (coplanar)

Action and reaction, Newton's third law, reduction of "N" coplanar forces to a simple set, equilibrium of three coplanar forces

5. Specialized Mathematics

When conditions permit their introduction, specialized courses in mathematics related to Electricity, Machine Shop, Woodworking and Industrial Science can be stimulating to the students of these options.

6. Theoretical Geometry (optional)

A knowledge of geometric methods and logical reasoning as applied to this subject with some practice in the solution of deductions

The following propositions are suggested:

Book I—Propositions 1, 2, 3, 4, 11, 16, 17, 19, and 20
Book II—Propositions 1, 2, 3, 4, 8, and 14
Book III—Propositions 8, 9, 11, and 15
as found in A Modern Geometry for High Schools (Macmillan)

SCIENCE

Four-Year Programme

The Science, Technology, and Trades Branch

Objectives

(a) To arouse curiosity regarding natural objects and phenomena, in order to develop an understanding of the elementary facts of nature

(b) To teach pupils to observe accurately, to draw logical conclusions from their observations, and to state them clearly and concisely

(c) To develop the ability of the pupil to organize and correlate facts

(d) To interpret correctly the printed page

(e) To develop a better understanding of the fundamental principles of science as applied to materials, machines, and processes with which pupils come in contact

To realize these objectives laboratory instruction should be organized to permit pupils to work individually or in small groups. The number of pupils working together will depend, to some extent, on the size of the class, on the equipment available and on the topics studied. For certain topics, where the order in which the experiments are taken is not fixed, the experiments may be carried on simultaneously.

Teachers may find it necessary to set up certain pieces of apparatus as permanent equipment to be in readiness for frequent use. Whenever possible, other equipment used should be assembled by the pupils.

Some teachers may wish to make greater use of the "unit", or "topical", plan. Such a plan of study follows the growing interests of the pupils and, where the organization of the instruction permits, teachers should not hestitate to rearrange the content of the courses to suit this unit plan.

In employing the unit plan the teacher will organize the greater part of the course of study under a number of units, projects, or problems, which will require for their solution investigation, experimentation, close observation, and reporting by the students working in groups. Usually groups are working on different projects (or for variation of the plan, on separated aspects of the same general project) at any one time since groups will vary in their rates of working and since the amount of equipment available may be somewhat limited.

The course of study may not be fully covered merely by the completion of a required number of units. The scientific method will have been set up, however, and the interest of the students so aroused as to permit effective use by the teacher of lesson presentations of the well-known formal type, together with pupil centred discussions and reviews. Units chosen to implement this plan should take in to account the age grade of the pupils, equipment available, size of class, and other pertinent factors. Units might be built around such topics as, Heating Our Homes, Water Systems for Our Homes, Rust and Corrosion.

The unit plan, of course, cannot be operated successfully without complete advance planning and preparation by the teacher. There must be available to the pupils sufficient instruction aids, and illustrative and resource materials organized in an orderly environment, to enable them to profit from this plan.

The time alloted to the study of General Science in the Science, Technology, and Trades Branch may not be sufficient to complete all the topics outlined. Teachers should select from these courses the content best suited to the needs of the pupils. Approved methods of teaching should not be sacrificed to cover every detail of the course. Where classes are large, they should be divided for at least one double period per week to permit the pupils to do experimental work.

Suitable text-books, as well as books of reference, should be provided in laboratories and in classrooms where science is studied. Illustrative material, such as pamphlets, charts, process diagrams, and sample products should also be procured and filed for ready reference. Pupils should be encouraged to use these books and materials to secure additional information on the topics studied, and to understand the practical application of scientific principles and to realize their value.

Note: Each school has the privilege of changing the order of presentation of the topics to suit its convenience.

Grade 9

The course of study for Grade 9 is that outlined in Curriculum I.1(e) Science Intermediate Division. Where a local curriculum committee has modified this course to suit the needs of the community, the modified course may be followed.

Grade 10

Note: Since some of the topics of this course have been introduced in the earlier grades, some review or teaching of these topics may be necessary.

The principles involved in this course should be developed through experiments, and these, as far as possible, should be performed by the pupils. In each case, practical applications should be considered and discussed in their relation to industry, and suitable problems should be used extensively.

The teacher should observe extreme caution when dangerous chemicals and highly volatile liquids are used.

1. Heat

The calorie: measuring calories; heat lost or gained; the large calorie; the energy value in foods; the British Thermal Unit; the use of the B.T.U.

Specific heat; comparison of some specific heats; the use of water as related to its high specific heat

Heat transfer: conduction; convection currents; transfer of radiant energy

2. Change of State

Review fusion and solidification; change of volume, latent heat of fusion; latent heat of vaporization; conversion of water to steam; expansion of water when frozen

3. Force, Energy and Power

Types of force: tension; compression; shear, reacting forces; measurement of force; Hooke's law

Pressure: Pascal's law

Molecular force: surface tension; adhesion; cohesion; capillary action

Force and motion: Newton's first law; Newton's third law

Energy: potential and kinetic; conversion of chemical energy into heat; conversion of one form of energy into another

Power: the units of work; the lever as a machine; relation between effort and load; the meaning of power; the watt; the horsepower

4. Combustion and Slow Oxidation

The rusting of iron filings or steel wool; slow oxidation of linseed oil; spontaneous combustion

The composition of air; liquid air as a source of commercial oxygen, nitrogen and neon; the gases, argon, neon, krypton, xenon, radon; the commercial uses of these gases

Oxygen: physical properties; the combustion of charcoal, sulphur, magnesium and iron in air, and in oxygen; the physical and chemical properties of the products

Hydrogen: preparation and properties; the presence of hydrogen in fuels

Carbon dioxide: properties and uses; properties of carbon monoxide; the production of carbon monoxide in combustion of fuels; carbon monoxide poisoning

Combustion of candle wax, alcohol, and coal to discover the products of combustion; complete and incomplete combustion; the explosive nature of fumes and dust

Corrosion: atmospheric oxidation of metals; methods used to combat corrosion; protection from corrosion such as surface coating, galvanizing, and plating; preparation of metals for soldering and welding; fluxes

Optional Topics

Word equations and symbol equations for some of the changes discussed. The meaning of element and compound

5. Fire Fighting

Starting fires: kindling temperature: the high and low kindling temperatures of fuels

Putting out fires: the reduction of temperature below the kindling temperature; the need of oxygen for combustion; the use of smothering gases; methods of putting out gasoline and other liquid fires; fire extinguishers

Methods of fireproofing paper, cloth, and wood

6. Solutions

Review the use of water as a solvent

The composition and characteristics of anti-freeze solutions, and of storage battery electrolyte; experiments, (i) to determine the density of these solutions by means of an hydrometer, and (ii) to show the capacity of an electrolyte to conduct a current of electricity; application of the information obtained from the density readings; a brief discussion of the industrial use, as solvents, of water, alcohol, acetone, and lacquer solvents

7. Lubrication and Lubricants

Friction: how it is produced; the effect of friction; the need for and action of lubricants; types of lubricants; viscosity and S.A.E. ratings; the effect of temperature changes on viscosity; flash point

The deterioration of a lubricant by dilution, dust, and sludge formation; the effect of the oil filter

A comparison of suspensions and solutions

8. Metals and Alloys

The composition, characteristics and use of cast iron, wrought iron, carbon steel, plumber's fine solder, wiping solder, brazing solder, low melting point alloys, metals for bearings, and stainless steel

The production of a simple alloy, such as solder. Comparison of the melting point of the alloy with those of the metals used

9. The Composition and Classification of Foods (optional)

Water in Foods: experiments to show that foods contain water, and how the percentage of water may be determined in such foods as fresh vegetables, fresh fruits, cereals, butter

Carbohydrates: an experiment to detect the presence of starch in flour, potatoes, etc. An experiment to contrast sugar with starch in respect to solubility and taste. An experiment to show the presence in starch of (i) carbon, (ii) hydrogen and oxygen (as shown by the condensation of water). An experiment to show the conversion of starch to sugar (i) by the action of saliva, or (ii) by boiling with dilute hydrochloric acid. (Note change in appearance, action on hot Fehling's solution or Bendict's solution)

Fats: experiments to show that fats (i) are insoluble in water, (ii) are soluble in carbon tetrachloride, (iii) produce a persistent greasy translucent spot on paper. An experiment to detect the presence of fat in butter, nuts, cheese, whole milk, etc.

Proteins: the composition and occurance; experiments to show (i) that proteins are characterized by a disagreeable odour when being charred, (ii) the spot test with nitric acid and ammonium hydroxide

Mineral Salts: an experiment to show the presence of ash or mineral matter in such foods as rolled oats and potatoes, by gently burning until combustion is complete

The Combustion of Common Foods: a discussion of the role of carbohydrates, proteins, fats, mineral salts, and water in the diet, and the relative proportions of the food constituents listed above in such common foods as flour, rice, beans, honey, butter, lard, salad oil, peanut butter, meat, eggs, fish, cheese. Experiments to show that milk contains (i) water, (ii) sugar, (iii) fat, (iv) casein and albumen, (v) mineral matter; the value of milk as a food

A brief discussion of the Carbon Cycle: recall photosynthesis, stressing the absorption of energy in a reaction which is the reverse of the oxidation of carbon-containing substances

10. Elementary Mineralogy (optional)

Physical Mineralogy

Physical properties of minerals (omit hardness)

Scale of hardness as used in the identification of minerals

Identification of quartz—massive, jasper, flint; identification of feldspars; comparison of orthoclase and plagioclase feldspars.

Native minerals—identification of gold, silver, copper, sulphur, graphite, coal

Sulphides and arsenides—identification of iron pyrites, copper pyrites, galena, molybdenite, smaltite, zincblende

Chlorides, fluorides, and carbonates—identification of halite, fluorite, calcite, dolomite, magnesite, malachite, azurite

Silicates—identification of hornblends, augite, garnet, olivene, epidote, tourmaline, mica, chlorite, serpentine, kaolin

Phosphates and sulphates—apatite, barite, celestite, gypsum, wolframite, scheelite

Rocks:

Common rock-forming minerals

Definition of a rock; classification of rocks

Igneous rocks—formation; identification of granite, syenite, diorite, gabbro, diabase basalt, fine-grained, even-textured rocks such as felsite and basalt, very fine-grained glassy rocks such as porphyry

Sedimentary rocks—formation; identification of conglomerate, breccia, sandstone, shale

Metamorphic rocks—formation; identification of gneiss, schist, quartzite, slate

Chemical Mineralogy:

The use of the blow-pipe; reduction and oxidation of litharge in the blow-pipe flame

Identification of arsenic, antimony, bismuth, copper, iron, lead, silver, and sulphur, by means of chemical tests

11. Botany - see Curriculum I 1(e), Grade 10

A brief treatment of flowering plants: general structure; pollination; fertilization; seeds, fruits. A brief treatment of non-flowering plants: fungus plants; bacteria; viruses

Grades 11 and 12

These Courses of Study are based upon the scientific requirements of the Shop Work Courses for Science, Technology and Trades Branch.

While every effort should be made to have pupils follow an experimental course, or treat the topics as pupil-research topics, the presentation of many of the topics requires discussion by the class. The pupil should be encouraged, therefore, to acquire knowledge and understanding through his own individual efforts, and to make use of suitable reference and illustrative materials, which should be available in a properly indexed form.

The core topics are listed, and those parts indicated with an asterisk are suggested as enrichment topics, to be used as circumstances warrant. If time permits, it may be desirable to include topics which apply to local industries. In the Chemistry course, some teachers may wish to stress such topics as agricultural chemistry, metals, polymers, and plastics.

Note: These topics need not be taken in the same order as listed here.

Grade 11

Physics

1. Accurate Measurements

Review of units of linear measure (English and Metric); practice in the use of the steel rule and calipers; construction and use of vernier calipers and micrometer; problems involving volume of regular solids using vernier calipers, tolerances, significant figures; measurement of masses of the foregoing solids and determination of buoyancy

Fine measurement of volumes and masses may be best combined with experimental work on density and specific gravity. See topic 2

2. Mechanics of Fluids

Experiments to determine the density of liquids by using the specific gravity bottle and the hydrometer; the specific gravity of heavy solids; solids lighter than water; fluids by means of the hydrometer. A discussion of the various scales in use

Problems on density and specific gravity

3. Machines

Review of Grade 10 work. An experimental study of the three classes of levers to determine the mechanical advantage of each. The classification and use of such levers as are found in the shops

A study of the class, mechanical advantage and application of the pulley, toothed gear, wheel and axle, inclined plane. Study and classification of the wedge, the screw, the differential pully and complex machine parts

A study of the mechanical advantage and efficiency of some simple machines which use these principles

Rules for calculations and problems

4. Force

Review the meaning and kinds of force

The units for measuring force: pound, gram; the meaning of H.P.; a demonstration of B.H.P.

Experiments to determine: the equilibrant and resultant of parallel forces; equilibrant and resultant of two forces acting at an angle; verification of the law of the parallelogram of forces

A discussion of the moment of force; the application of the moments of force to the lever and the wheel and axle

Study of: friction coefficient of; laws of motion--helicopters, jets; projectiles; Bernoulli's principle--speed indicators, pitot tube

Mechanics of motion: impulse and momentum; acceleration due to gravity and in machines "g" factor

5. Electricity

Review current electricity, and the meaning of work, energy and power with emphasis on gravitational potential energy

A study of electromotive force and factors controlling electric current flow; magnetic effects of electric current; applications of electromagnetism; D'Arsonval galvanometer; the ammeter and voltmeter

An experiment to determine the resistance of a conductor using the voltmeter-ammeter method. Simple problems involving Ohm's Law

Experiments to show induced currents--principle of the induction coil

Simple experiments to illustrate the fundamental principles of the A.C. and D.C. transformer, motor and generator (structural details are not required)

Heating and lighting effects of an electric current, fuses, and circuit breakers

Industrial uses of electric current: (1) welding, (2) electric furnace, (3) electric lamps (incandescent, mercury vapour, soldium vapour, neon, fluorescent)

*Thermocouple to measure temperature, (A.C. and D.C. currents); induction; transformer; radio-tube electronics; transistors; photo-electric cells

6. Light Energy

A discussion of light as radiant energy--two concepts

Experiments to show: the composite nature of white light; the colours of the solar spectrum; reflection from plane surfaces; images in plane mirrors, and curved mirrors; refraction of light; the uses of lenses

Applications of curved mirrors--headlight, rear vision; lenses--eye, camera, movies, stereo pictures, projection

The physical nature of colour; Newton's experiment; the colour of objects in white light

The structure of the human eye, and methods of correcting defects with glasses

*Colour blindness; colour mixing; Kodachrome; 3D colour process; 3D movies

7. Lighting for Vision

A study of the accepted standards of illumination used in modern lighting for home, school, factory, display, flood lighting; the law of inverse squares; the incandescent lamp measurements; the principle involved in and use of a light meter

*The meaning of plane-polarized light. Simple experiments to show the nature and effects of polarized light, using a pair of polarized disks; the application of polaroid to automobile driving as glare prevention with sun glasses

8. Heat

Review or study of heat units, and heat capacity. An experimental study of: specific heat of water; specific heat of metals; heat of fusion of ice; heat of vaporization of water; heat of vaporization of other liquids; the effect of increased and decreased pressure on the boiling point of liquids

Application of the above principles as in heating and refrigeration

Review of hydrometry. The principle of air conditioning, particularly in respect of moisture content

9. The Lead Storage Cell

An experiment to show: electroplating with copper sulphate solution; the preparation of the electrolyte

Review of the use of the hydrometer and discussion of the use of the density-concentration tables

An experiment to "form" a storage cell, using lead plates, with a reference to the composition of the plates before and after forming. "Discharging" the cell and the alteration of potential as shown by the voltmeter; degree of discharge

A discussion of the charging of the cell with special reference to the transformation of electrical energy to chemical potential energy; and the discharging of the cell in terms of the reverse transformation of energy

The efficiency of the commercial storage battery; a comparison of the output of electrical energy with the input of electrical energy; reference to the dissipation of some energy in heating the cell and decomposing the electrolyte

10. Metallurgy

A discussion of the kinds and sources of iron ores, such as sulphides, oxides, carbonates. Separation from the rock, concentration and extraction. Flotation, roasting, and reduction

The construction of the iron blast furnace, and reference to the heat exchange in a stove

A demonstration of carbon monoxide as a reducing agent. Recall the dangerous properties of carbon monoxide

An examination of the constituents of the blast furnace charge, and the purpose of each substance, in the operation of the blast furnace

The construction and use of the iron cupola

The composition and characteristics of cast iron, carbon steel and wrought iron

A brief study of the manufacture of steel by (1) the acid Bessemer process, (2) the basic open-hearth process

The heat treatment of steel; methods and purpose of annealing, hardening, tempering; surface hardening by (1) case hardening, (2) nitriding. This should be coordinated with projects in heat treatment in the machine shop

The composition and characteristics of types of steel: tool, nickel, tungsten, manganese, stainless, silicon

11. Alloy Steels and Alloying Metals

The meaning and purpose of alloys

Review of properties of metals and chemical reactions serving as tests

Some common alloys and their industrial applications

The replacement series of metals

A discussion on corrosion and its prevention

Grade 12

Chemistry

1. The Meaning and Purpose of Chemistry as Compared with Physics

Review of the states of matter. The use of the physical properties of a pure substance in its identification

2. Chemical Change

Experiments to show chemical change in contrast with physical change and methods for distinguishing between them. Heating mercuric oxide; electrolysis of water; light on silver halide, catalytic action of manganese dioxide. How new substances are formed, energy change

3. Mixtures

The meaning of mixtures, and the difference between a mixture and a pure substance

Experiments on separating mixtures: magnetic; filtering; settling; starch filtering; flotation; solvent extraction; distillation; freezing; crystallization

A study of the application of these types of separation in industry

4. Elements and Compounds

An experiment on the decomposition of a compound

A comparison of mixtures and compounds

The meaning of an element and a compound: definition; method of naming; the structure of the atom; simple chemical reactions; reacting weights and atomic weights; symbols, formulae, equations, valency

The gas laws; measurement of gases; changing the volume, pressure or temperature of a gas. Problems on the application of the gas laws

The molecule and determination of molecular weights

5. Oxygen

Review the composition of air

Experimental review of oxygen - preparation, properties, test, uses (e.g. oxy-acetylene welding, oxygen masks, oxygen tents)

6. Hydrogen

Experimental review and extension of work on hydrogen preparation from water and from acids, properties, test, uses (e.g. oxy-hydrogen torch, weather balloons, constituent of gaseous fuels, hydrogenation of fuels)

7. Solutions

Review and extend work on solutions to include:

Comparisons of characteristics of solutions with those of mechanical mixtures

Examples of solutions. These should be varied enough to show the existence of solutions in different physical states: e.g. air, including water vapour; low-melting alloys; gold and copper alloys; oil or grease in carbon tetrachloride; DDT in kerosene; carbonated beverages

Meaning of terms: solvent, solute, solubility (relative and quantitative); saturated, unsaturated, and super-saturated solutions; solubility curve (to illustrate change of solubility with temperature). Factors which affect the rate of solution

8. Acids, Bases, and Salts

Experiments to show the combustion in oxygen of carbon, sulphur, and red phosphorus; the reaction of these oxides with water, and the effect of their solutions on litmus

Acidic oxides—acid anhydrides: hydrochloric, nitric and sulphuric acids

An experiment to show the combustion of magnesium in oxygen

A demonstration of the combustion of sodium in oxygen

The reaction of these metallic oxides with water, and the effect of their solutions on litmus. Basic oxides—basic anhydrides

Discovery of further properties of acids (dilute) using (1) other indicators, (2) action on carbonates, (3) action on suitable metals (magnesium), (4) taste as shown by soda water, vinegar, sour milk, etc.

Discovery of the effect of bases on the indicators used for acids

Experiments to show the reaction between acids and bases; the products of the reaction (neutralization), water, and a salt which is left as a residue upon evaporation of the water

A brief discussion of the commercial recovery and industrial importance of common salt (sodium chloride); a study of its properties; a study of the preparation and properties of hydrogen chloride and of hydrochloric acid

9. The Theory of the Ionization of Acids, Bases, and Salts

A demonstration of the electrolysis of cupric chloride solution, with an explanation in terms of charged particles

A discussion of the dissociation of cupric bromide, hydrogen chloride, when dissolved in water giving rise to electrically charged particles, called ions

A discussion of the hydrogen ion as the characteristic ion of acids; of the properties of acids (taste, effect on litmus and other indicators, action on metals, etc.) as being due to hydrogen ions in the solutions

A discussion of the dissociation of sodium hydroxide in solution

A discussion of the hydroxyl ion as the characteristic ion of bases; the properties of bases (taste, effect on litmus and other indicators, caustic action on animal and vegetable matter, e.g., textiles (mercerization of cotton), as being due to hydroxyl ions in the solutions

A discussion of neutralization as a quantitative reaction depending upon the removal of hydrogen ions and hydroxyl ions to form water

A brief discussion of the measurement of acidity in terms of hydrogen ion concentration

*How an atom becomes an ion

*The meaning and measurement of pH—the effect of pH on life and growth

10. Miscellaneous Topics

Titration in control laboratories and ionization. Equilibrium and mass action—reversible and complete hydrolysis, illustrated by copper bromide

An experiment to show commercial electroplating

The electrolysis of a sodium chloride solution and the recognition of the products

Refining of copper, silver and gold; production of chlorates and hydrogen peroxide

Electric furnaces for graphite, silicon, carborundum, carbide, alundum, phosphorus, carbon disulphide

11. Combustion and Fuels

Experiments to show that certain mixtures of gasoline or acetylene and air give complete combustion, and that others give incomplete combustion

A discussion of complete and incomplete combustion of hydrocarbons

Review the formation of carbon monoxide in the automobile engine, and during the combustion of coal or coke

Experiments to illustrate the complete and incomplete combustion of acetylene

The use of the oxy-acetylene flame for welding, with special reference to the correct mixture of oxygen and acetylene

Repeat the experiment to show the burning of iron in oxygen

The use of the oxy-acetylene flame for cutting, with special reference to the correct mixture of oxygen and acetylene

Review of the structure of the Bunsen burner and its flame

A discussion of the complete and incomplete combustion of natural gas or coal gas

A review of explosive mixtures with special reference to the "striking-back" of the flame of the Bunsen burner

A study of the oxidizing and the reducing zones of the gas flame

A discussion of the world locations of petroleum oil, and the methods and channels of distribution, with specific reference to the requirements of the British Commonwealth

Experiments to illustrate (1) the distillation of water, and (2) the fractional of a water-alcohol solution

A discussion of the principles of fractional distillation and cracking in petroleum refining

A brief discussion of types and grades of motor fuels; octane numbers

A recall of lubrication and lubricants, Grade 10

An examination of other petroleum products, with a brief outline of their uses

A brief discussion of other fuels such as coal, industrial gases

12. Limestone

The composition, properties and uses of limestone

An experimental study of the preparation and properties of quicklime; the kinds of quicklime

An experimental study of the preparation and properties of slaked (hydrated) lime; the action of carbon dioxide on slaked lime

An experiment to show the preparation of lime-sand mortar, its initial set, and final hardening. Other uses of slaked lime

13. Gypsum

The composition, properties and uses of gypsum

Experiments to show:

(a) the action of heat on hydrate such as blue vitriol, and the action of water on the anhydrous residue
(b) the conversion of gypsum into plaster of paris
(c) the effect of the addition of water to plaster of paris

A discussion of other gypsum products such as wallboard, gypsum blocks, and acoustic materials

14. Cement and Concrete

A study of the composition, properties and manufacture of cement

An experiment to study the initial set and final hardening of cement

A study of the composition and function of the components of concrete, effect of impurities, moisture, temperature, mixing, and the strength of the mix

A comparison of the setting of concrete with that of lime-sand mortar

How to determine quantities for concrete. The uses of concrete

Recall the expansion of water on freezing, and its application to the disintegration of concrete

Recall the action of carbonic acid on limestone, and discuss the similar disintegrating action on the calcium salts in concrete

15. Wood

A brief discussion of the chemical composition of wood

Experiments to show:

(a) the effect of heat on wood at various temperatures; the meaning of kindling temperature; wood as a fire hazard

(b) the protection of wood against fire by covering the wood with fireproof coatings as sodium silicate. Other protective coatings: plaster, asbestos, fire-resistant paints, impregnation of the wood with chemicals such as ammonium phosphate, ammonium sulphate, or borax. The function of these non-combustible chemicals in diluting the combustile gases given off by the hot wood

(c) the open-tank process and the Kyanizing process for the preservative treatment of wood; methods employed for impregnating wood with preservatives

Brief discussion on:

(a) fungus decay of wood and the conditions necessary for the development of fungi in wood

(b) kiln drying for the preservation and seasoning of wood

(c) the application of paint, varnish and lacquer to the preservation of wood; an experiment to compare the effect of air on a thin film of linseed oil and of mineral oil

16. Metals

A brief study of the properties and industrial application of metals such as aluminum, magnesium, lead, tin, zinc, copper, nickel, beryllium, cadmium

17. *Organic Chemistry

A brief study of straight-chain and ring-structure, alcohols, acids, esters, acetone, solvents, formaldehyde, ether

18. The Halogens

A brief study of the halogens to show that all chemical elements can be arranged in family groups, the members of which are closely related. This can be combined with a study of the Periodic Table

19. For Students of Electronics

*A discussion on radio-active metals and materials leading up to nuclear fission